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INTRODUCTORY MENTAL ARITHMETIC

FOR

PUPIL TEACHERS

AND

THE ADVANCED PUPILS OF MIDDLE-CLASS AND ELEMENTARY SCHOOLS;

BEING

A SHORT EXPOSITION OF THE USES OF MENTAL ARITHMETIC,
WITH ILLUSTRATIVE EXAMPLES,
AND A GREAT NUMBER OF NEW AND ORIGINAL EXERCISES.

BY

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Author of "Mental Arithmetic for Training Colleges," &c.

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MENTAL ARITHMETIC.

INTRODUCTION.

I.

THIS little book seeks as much to indicate the manner in which Mental Arithmetic may be used as to provide young teachers with Exercises to be worked by their pupils.

It is necessary to explain that we consider the chief uses of Mental Arithmetic to be—

1st. *To give Facility in Computation* by teaching children to dispense with the slips of paper they are apt to use in making even easy calculations.

2nd. *To impress on the memory of the pupils any numbers which it may be desirable they should remember*, such as the length of a river, the date of a battle, &c., &c.

3rd. *To lead up to and to introduce all new Rules in Arithmetic*, thus proceeding from the known to the unknown. As an Exercise in inductive reasoning this use of Mental Arithmetic is perhaps the chief.

4th. *To illustrate and confirm the Rules of Arithmetic thus found.* Here it is particularly useful, because by it a teacher can ascertain almost in a moment how many of his class have understood his exposition of a Rule.

5th. *To provide short methods of finding required results.* This branch of the subject is more dealt with in the author's "Mental Arithmetic for Training Colleges;" it will, however, be slightly dealt with here.

6th. *To develope and strengthen the Reasoning Faculties of pupils.* This it does by teaching them to reason out Rules from the teaching of particular Examples, to apply these Rules to new Exercises, and to disentangle problems. It also cultivates the Memory by causing the pupils to remember the Rules and the numbers involved in Exercises, as well as—in the case of oral questioning—the Exercises themselves.

II.

These different *uses* will form the subjects of the Chapters into which this book is divided. In

CHAPTER I. will be found Examples and Exercises intended to give pupils a *power* and *facility* of finding, by Mental Arithmetic, results which—if left to themselves—they would seek to find by paper work. In

CHAPTER II. will be given Examples and Exercises of the Second Use mentioned above. It may be called "*Incidental Mental Arithmetic.*"

CHAPTER III. will contain an Example shewing the inductive process by which it is here proposed to teach all the ordinary *Rules* of Arithmetic, and Exercises on the Elementary Rules of Arithmetic as far as Simple Proportion. This Chapter will therefore attempt to attain the 3rd and 4th uses mentioned above, and may be termed "*Inductive Mental Arithmetic.*"

CHAPTER IV. will contain a few short and easy Rules of Mental Arithmetic, and Exercises upon them.

CHAPTER V. will consist of Miscellaneous Examples and Exercises intended, as far as possible, to examine upon all the preceding Chapters, and at the same time to furnish some additional problems to be solved by methods which the pupils can find for themselves.

III.

We can recommend some such plan as the following for making use of this book:—Provide each pupil with a slip of paper numbered according to the number of questions it is proposed to ask; then,

with young pupils, write the Exercise on a Black Board, and suddenly present it to the class, requiring them to write their answers opposite the number of the question to which it refers. With more advanced pupils, read out the question once or twice, as it is thought necessary, instead of writing the questions on a Black Board.

To cultivate brilliancy and rapidity, divide the class into sections pretty well matched for ability, put question after question orally, take an answer only from the first boy who puts his hand up, and if his answer be correct let that be counted ONE to his section, and let that section be accounted the winner which first scores a given number, say SIX. Let it always be remembered, however, that such plans as this last cultivate sharpness rather than solidity, and that, unless modified according to circumstances, the struggle will almost always lie between some five or six children, the rest being simply spectators.

When each child is provided with a text-book, the above plans may be modified by requiring the pupils to find a certain page, and then calling upon some particular pupil to give the answer to a certain sum upon that page. Many other plans and modifications of these will suggest themselves to teachers; we merely give these as suggestions.

IV.

The Exercises provided in this little book will sufficiently indicate their own purpose, viz., *not* so much to supply a number of *easy* problems such as any moderately well-informed boy or girl could frame at a moment's notice, as to provide Exercises of a more difficult character for the use of advanced pupils and all Pupil Teachers. As far as possible, the aim of the Exercises—especially the Miscellaneous Exercises—is to cultivate not only a power of finding results in Arithmetic with ease, rapidity, and certainty, but also a *power of applying the mind to the solution of difficult problems.* For this reason most of the questions deal with Concrete numbers, and we may here observe that the teacher will do well—especially with young children—to frame all his Mental Arithmetic questions on Concrete numbers, and, when possible, to make them interesting and lively, and even laughable.

CHAPTER I.

1. THE EXTENDED MULTIPLICATION TABLE—i.e., from 13 to 24.

The children should be taught these tables in a manner somewhat similar to the following:—

Specimen of Teaching *—

(1.) *Twelve twos* = ? 24 + 2 = ? ∴ Thirteen twos = ? ∴ Two thirteens = ?

(2.) If there are two rows of boys, each containing 13, there are altogether —— ?

(3.) If one horse be worth 2 donkeys, thirteen horses are worth —— donkeys?

Therefore, THIRTEEN TWOS ARE **26**.

2. THE EXTENDED PENCE TABLE.

Specimen of Teaching—

(1.) *Twenty pence* = ? ∴ 30d. = ? 20 + 30 = ? 1s. 8d. + 2s. 6d. = ? ∴ 50d. = ? ∴ 100d. = ?

With advanced pupils, continue as follows:—

∴ 1000d. = ? ∴ SIX THOUSAND PENCE = £25.

(2.) Again, *Twelve pence* = ? and, 12 × 10 = ? ∴ 120d. = ? 120 × 10 = ? ∴ 1200d. = ? and 1200 × 5 = ? ∴ SIX THOUSAND PENCE = ?

---

* In all these *specimens of teaching* it will be observed that the teacher makes use of what the children *already know* to lead them on to find out *new* things. In every case that which they are supposed to know will be printed in *small italics*, and what it is proposed to lead them to discover will be printed in SMALL CAPITALS.

And *vice versa*—

(1.) *One shilling* = 12 *pence*, ∴ 10s. = ? ∴ £1 = ? ∴ £1, 10s. = ? ∴ £3 = ?

Therefore, THREE POUNDS = **720**d.

(2.) *One shilling* = 12 *pence*, ∴ 3s. = ? ∴ 30s. = ? ∴ 60s., *i.e.*, £3 = ?

Therefore, THREE POUNDS = HOW MANY PENCE?

Observe, that by two different processes we found the value of *six thousand pence* and *the number of pence in* £3. In practice it would be well to find such values in SIX or EIGHT different ways, until, in fact, the teacher observes that most of the pupils remember just what he wishes them to know—*e.g.*, *that* 6000*d.* = £25.

After a great many such lessons as these, the pupils will be ready to learn by heart the Extended Multiplication and Pence Tables; but the young teacher must carefully remember that he is not to require his pupils to commit these to memory before they have been taught them thoroughly by such oral teaching as has been exemplified above.

3. THE TABLES OF ALIQUOT PARTS AND THEIR USES.

Specimen of Teaching—

(1.) *Six shillings* × 3 = ? and, *Eight pence* × 3 = ? ∴ (6s. × 3) + (8d. × 3) = ? ∴ 6s. 8d. × 3.

(2.) 80 × 3 = ? and 24d. = How many shillings? And 24d. × 10 = How many pence? ∴ 240d. = ?

But 80d. = 6s. 8d. ∴ 6s. 8d. × 3 = ?

(3.) The price of 3 hats at 6s. 8d = ? ∴ The price of 6 hats = ?

Therefore, ONE-THIRD OF £1 = 6s. 8d., or
THREE TIMES 6s. 8d. = ONE POUND.

4. MULTIPLICATION BY 12 AND BY 20.

Ex. 1. £3, 2s. 4½d. × 12.

Specimen of Teaching—

Working such a sum as this on the B. B., the children begin thus:— 2f. × 12 = 24f. = 6d. Carry 6. 4d. × 12 = 48d., and 48d. + 6d. carried = 54d. = 4s. 6d. Set down 6 and carry 4. Having got as far as this, let the teacher begin thus:—

One penny × 12 = one shilling .·. **2** pennies × 12 = ? and, **3** pennies × 12 = ? and, **4** pennies × 12 = ? and, half-a-penny × 12 = ?
.·. 4½d. × 12 = ?

Ex. 2. £3, 5s. 6d. × 20.

5s. 6d. = 5½s. Now, **one shilling × 20 = one pound.**
Therefore, as above, 5½ shillings × 20 = 5½ pounds = £5, 10s.

N.B.—The process will be reversed for Division. Arithmetic is full of such examples; let the teacher look for them carefully, for children like such little "dodges" immensely, and they are very useful in business.

The one golden rule in all these lessons is "*tell* the children as *little* as possible, but teach them to find out as much as possible."

Exercise 1.*

1. What is the value of 19 cows at £20 each?
2. If a cow is worth 7 sheep, 23 cows are worth —— sheep?
3. Six bags of potatoes contain in all 648, how many in each bag?
4. What is the price of 7 yd. of calico at 10d. per yard?
5. Thirteen pounds of salt at ¾d. per lb.?
6. If 3 lb. of potatoes cost 2d., how many lb. for 1s.?
7. If 2 lb. of tallow cost 1s. 3d., what is the price per lb.?
8. If 2 cabbages cost 1¾d., what is the price of 6?
9. What is tea per oz. when 3 oz. cost 10½d.?
10. What is the price of an egg when 1 doz. cost 1s. 9d.?
11. If 1 pear be worth 3 plums, how many plums are worth 2 pears and 3 plums?
12. How many oranges are worth 9 pears and a penny, if 1 orange is worth 3 pears, and you can buy 2 oranges for a penny?
13. A house and a piece of land are sold for £100. If the land is valued at £30, what was the price of the house?
14. Fifteen new bonnets at 10s. each?
15. Six ton of coal at £1, 10s. a ton?

---

* All the Exercises are intended as much to afford models for the teacher in asking questions as to form actual Exercises for the pupil.

Exercise 2.

1. After a number had been multiplied by 8 it came to 96. The number = ?

2. After a number had been divided by 4 it gave 21 as the answer. What was that number?

3. What is that number which being increased by 19 comes to 40?

4. Take 14 from a certain number and it leaves 76. That number is?

5. Five boys hire a donkey, and the charge is 2s. 6d. How much must each pay?

6. The cost of 12 penholders at $\frac{3}{4}$d. each = ?

7. The value of 1 dozen copy-books at $1\frac{1}{4}$d. each = ?

8. How many books are there really in a trade *gross* at 13 to the dozen?

9. Two such gross at 4s. 6d. for 12?

10. The price of 13 at $2\frac{3}{4}$d. each?

11. Twenty-four feet of carpet at 1s. 7d. per foot?

12. 96 oranges at $\frac{3}{4}$d. each?

13. 48 baskets at 8d. each?

14. 72 new blackboards at 6s. 8d. each?

15. A costermonger buys cauliflowers at $\frac{3}{4}$d. each, and sells them at $1\frac{1}{4}$d. each. What profit does he make on 99?

5. EXAMPLES IN PROPORTION.

Ex. 1. *If* 5 *oz. of tobacco cost* 1*s.* $0\frac{1}{2}$*d., what is the cos. of* $\frac{1}{2}$ *lb.?*

(1.) How many oz. = 1 lb? ∴ how many = $\frac{1}{2}$ lb.?

(2.) If 5 oz. of tobacco cost 1s. $0\frac{1}{2}$d., how do we find the price of 1 oz.? What *is* the price of 1 oz.? Then what is the price of 8 oz.?

Ex. 2. *If* $\frac{3}{5}$ *of the size of a board be* 36 *sq. in., what was the size of the board?*

(1.) How many *fifths* make a whole one? What name is given to *one whole one?** Then, how many *fifths* make *unity.*

---

* *Unity.* This is an Example of Incidental Teaching.

(2.) *If* 3 *oranges cost* 6*d.*, *what is the price of* 1? Why do you divide by 3 to find the answer here?

(3.) *If* 3 *sacks of corn weigh* 270 *lb.*, *what is the weight of* 1 *sack?* Can you find the answer to this question by dividing by 3?

(4.) Now if 3 *Fifths* = 36 in., what is 1 *Fifth?* Then, what is 5 Fifths? Is that the answer to the given question? Why?

Ex. 3. *If* 20 *tons of coal cost* £33, *what is the price of* 3 *tons?*

(1.) *What is the cost of* 20 *books at* 1*s. each?* at 2*s.* each? at 7*s.* each? What rule then do you see here?

(2.) *If, then, the price of* 20 *tons be* £17, *what is the price of* 1 *ton?*

(3.) Then, *what is the price of* 1 *ton when* 20 *ton cost* £33? Answer, 33*s.* Then, what is the price of 3 tons at 33*s.* per ton?

Exercise 3.

1. The cost of 7 reels of cotton being 10½d., what is the price of 3 reels?
2. If ¼ of a cwt. of sugar be worth 19*s.*, the price of 1 cwt. is?
3. Find the value of ⅝ of an acre of land at £7, 10*s.* per acre?
4. What was the price of a ton of coals when ¾ of a ton cost a guinea?
5. What is the price of 2240 walnuts at 16 a penny?
6. Nine pounds of butter being sold for 13*s.* 6*d.*, what was that per cwt.?
7. When eggs are 15*d.* a dozen, what is the price of a score?
8. If a ton of iron be worth £35, what is the value of 7 cwt.?
9. A hayrick contains 26 tons of hay worth £1 a ton. What is the value of $\frac{4}{13}$ of it?
10. If 1 lb. of snuff be worth 1*s.* 4*d.*, how much snuff is worth 7½d.
11. If ½ of a barrel of beer cost half a guinea, what is the price of a barrel?
12. A boy once multiplied a number by 4 instead of dividing it by 4; his answer was 112. What was the true answer?
13. He also once subtracted 35 instead of adding it, and so got 28 for his answer, instead of?
14. Seven pairs of fowls cost £2, 12*s.* 6*d.*, the price of each fowl was?
15. How many cabbages at 1½d. each are worth 1*s.* 0½d.

Exercise 4.

1. Multiply £1, 0s. 6d. by 17.
2. Divide £9, 10s. by 19.
3. If $\frac{1}{4}$ of a ship be worth £6200, the whole ship is worth?
4. If seven pairs of boots be worth £3, 13s. 6d., one pair is worth?
5. Three men and a boy earn £1, 15s. between them. If a boy's wages be one-half that of a man, what is his share of the money?
6. What is the value of 84 thirds of £1?
7. The cost of 73 flower-pots at $1\frac{1}{2}$d. each is?
8. If $\frac{1}{4}$ of a peck of potatoes cost $\frac{3}{4}$d., a peck will cost?
9. If 3 lb. of cocoa are worth 4 lb. of coffee, how much cocoa is worth 12 lb. of coffee?
10. 1 horse is worth 2 cows, and 1 horse and 4 cows are sold for £240, the price of 1 cow = ?
11. If 17 be multiplied by 9, how many must be taken from the product to leave 119?
12. A farmer sold 27 little pigs for £90, what was the price of each?
13. Thirty-five ounces of sweets at $1\frac{3}{4}$d. per oz?
14. A yard and three-quarters of calico at 10d. a yard?
15. $2\frac{3}{8}$ lb. of lead at 1s. 8d. per lb.?
16. A person takes 10s. to shop, and spends 4 times as much as he receives change. The money spent was?

CHAPTER II.

INCIDENTAL MENTAL ARITHMETIC.

6. EXAMPLE OF THE USE OF INCIDENTAL MENTAL ARITHMETIC.

In giving a lesson in Science, a teacher may wish his pupils to remember that, under certain conditions, the velocity of SOUND through air is 1090 ft. per second, while that of LIGHT is about 185,500 miles per second. Here the pupils will have two things to remember, viz. :—

1st. The numbers 1090 and 185,500.

2nd. That the number 1090 refers to FEET, while the other number refers to MILES.

The children may be assisted in this by being required to answer the following questions in Mental Arithmetic:—

(1.) *How many feet would sound travel through in* 5 *seconds? How many in* 11 *seconds? How many in half-a-minute?*

(2.) *When a gun has been fired one second, how far off must a person be if the sound requires* 3 *seconds more before it reaches him?*

(3.) *How far off must a star be if its light takes* 2000 *seconds to reach the earth?*

(4.) *How many* **yards** *does sound travel through per second?*

(5.) *How many* **furlongs** *does light travel through per second?*

The first three of these Exercises would impress the numbers 1090 and 185,500 by causing the children to *use* them; the last two would serve to impress that they referred respectively to *feet* and *miles* by the act of *converting* them, the one into *yards*, the other into *furlongs*.

Exercise 5.*

1. The Volga being ten times longer than the Thames, what is the length of the former river, that of the latter being 215 miles?

2. The head of the whale being in length one-third of its total length, what is the length of the head of a whale whose body and tail measure 84 ft.?

3. Alexander the Great died at Babylon, B.C. 323, and Napoleon I. was finally conquered at Waterloo, A.D. 1815; by how many years did the one event precede the other?

4. Tarquin had been expelled from Rome 466 years when Julius Cæsar was assassinated in that city, which latter event happened B.C. 44; what was the date of the former event?

5. Taking the length of the Mediterranean Sea at 2600 miles, and

---

* This Exercise is intended more to *suggest* questions than to provide a teacher with Exercises for his pupils. Each question, therefore, in this Exercise must be supposed to be suggested by the subject-matter of some ordinary lesson.

the extent of its coast-line at 13,000 miles, how many times is the former contained in the latter?

6. Quicksilver is 13½ times heavier than water; if, then, the atmosphere supports in a barometer 30 inches of quicksilver, how many feet of water will it sustain in a water barometer?

7. The Zambezi River is 2400 miles long, and the Victoria Falls in it are 900 miles from the sea. Walking 15 miles a day, how long would it take a negro to proceed from these falls to the source of the river?

8. The highest point at which railways have crossed mountains is probably about 8000 ft., viz., at a pass in the Rocky Mountains; the diameter of the earth is about 8000 miles; how many times therefore is the height above-mentioned contained in the earth's diameter?

9. The Nile is about 3000 miles long,* and its delta measures about 120 miles from its apex to the sea. How many times is the length of the delta contained in that of the entire course of the river?

10. The Zambezi is 2400 miles long, by how many times the length of its own delta does the Nile exceed the Zambezi in length?

11. The same amount of heat which would raise 1 lb. of *water* a certain number of degrees of temperature would raise 4 lb. of *air* a corresponding number of degrees. Now water is 770 times heavier than air; how many cubic feet of air then can be raised one degree in temperature by the same amount of heat as would raise one cubic foot of water one degree of temperature?

CHAPTER III.

INDUCTIVE MENTAL ARITHMETIC.

7. DIFFERENT METHODS OF TEACHING ARITHMETIC — THE INDUCTIVE METHOD.

At different times, and by different teachers, there have been three methods adopted for teaching Arithmetic, viz.:—

(1.) That by which the pupils are taught the Rule for working a

* Connect this with the fact that the highest mountains of England and Wales are above 3000 *feet*, *i.e.*, 1000 *yards*.

particular kind of sums—say *Simple Interest*—by merely working over Exercises again and again with the teacher, without any Explanation at all of the Reason of the Rule.

Such a system is bad in the extreme.

(2.) That in which the pupils are first taught the Rule, which is afterwards explained and illustrated by means of Examples.

This, from its compendiousness, is the method most frequently adopted in text-books of Arithmetic. It is much superior to the former one, *because it usually gives an Explanation of the Reason of the Rule.*

(3.) That by which the pupils are taught to discover the Rule for themselves, as in the following Example.

We will suppose a teacher about to give

An Introductory Lesson in Simple Interest,*

his object being to lead his pupils to discover

The Rule for Calculating Simple Interest on any given sum of Money at any given Rate per Cent.

The teacher will

I. **Introduce his Lesson** by explaining the origin of "*Interest;*" the meaning of such phrases as "*Three per Cent.,*" "*Rate,*" "*Principal,*" &c.

When his pupils understand all this, he will proceed to make them **use** their newly-acquired information by finding answers to the following.

II. **Questions in Mental Arithmetic—**

(1.) *What is the Simp. Int. on* £200 *at* 5 *p.c.? at* 10 *p.c.? at* 8 *p.c.?*

(2.) *What is the Simp. Int. on* £700 *at* 3 *p.c.? at* 6 *p.c.? at* 4 *p.c.?*

After a number of such Exercises as these, all of which the pupils are to work without yet knowing the Rule, the teacher will propose this question.

(3.) *What is the Simp. Int. on* £1733, 6*s.* 8*d.* *at* 3 *p.c.?*

---

* See the author's "*Advanced Arithmetic for Schools and Colleges,*" § 106.

The children, being unable to work this sum as they did the others, will become anxious to know how to do it. This anxiety of theirs will materially assist the teacher in keeping up their attention while he proceeds *to leave the difficult sum for a time*, and calls upon a boy to work once more an easy sum, *e.g.*, "*What is the Simp. Int. on £500 at 6 p.c. ?*"

The boy will readily answer, £30.

The teacher will then say, "*How did you do it.*"

From the boy's replies it will appear that the answer was found by considering thus :—

The Interest on ONE "*cent.*" = £6.
Now £500 = FIVE *cents.*
∴ *The Interest on* £500 = £6 × 5 = **£30.** *Answer.*
From which it appears that

$$\textit{The Answer} = £6 \times \frac{£500}{£100} = £\frac{6 \times 500}{100} = £\frac{500 \times 6}{100}$$
$$= \frac{\text{Principal} \times \text{Rate}}{100}$$

The teacher will similarly analyse the working of several other easy examples, and will then, *from the answers he receives from his pupils*, proceed to

III. Deduce the Rule from the foregoing Analyses.

RULE—Multiply the given Principal by the given Rate, and divide the Product by 100. The Quotient is the Simple Interest.

The children having been convinced that this Rule gives a correct result by finding that its results are in every case verified by working easy Examples, both by this Rule and by their own methods of Mental Arithmetic, the teacher will proceed to

IV. Apply the Rule to the Example left unworked. This he might do by requiring one of the pupils to work it on the black-board before the class in something such a manner as this—

$$\textit{The Answer} = \frac{£1733,\ 6s.\ 8d. \times 3}{100} = \frac{£5200}{100} = £52.$$

The teacher will next proceed to

V. Impress the Rule by giving his pupils a number of Exercises to be worked on their slates according to the Rule.

N.B.—In finding that "*Answer* $= \frac{\text{Principal} \times \text{Rate}}{100}$" (see II. above), we have so manipulated the fraction as to provide us with what we wanted, though a careful reader will notice that we have thereby presented a result not at first sight in strict accordance with the result of the analyses. For the Rule by which the Mental Exercises are worked seems to be this—

$$\textit{Simp. Int.} = \textit{Rate per Cent.} \times \frac{\text{Principal}}{£100}$$

So that

$$\textit{Simp. Int.} \text{ on } £1733, 6s.\ 8d. \text{ at } 3 \text{ p.c.} = £3 \times \frac{£1733, 6s.\ 8d.}{£100}$$

So that before we can go any further, it becomes necessary to "*Reduce* £1733, 6*s.* 8*d. to the fraction of* £100," *i.e.*, "*Find the value of* $\frac{£1733, 6s.\ 8d.}{£100}$."

The former Rule, however, avoids this difficulty, and may be reconciled to the last Rule by considering that *if the Simp. Int. on* £100 *be* £3, *that on* 100*s. must be* 3*s.*, *and that on* 100*d. must be* 3*d.*, so that when we divide £1733, 6s. 8d. by 100, the result is the Simp. Int. on that sum of money at ONE p.c.; therefore, if the Dividend be made three times greater—thus £1733, 6s. 8d. × 3—the Answer, being three times greater, will give the Simp. Int. at THREE p.c.

This, however, should not be brought under the notice of the pupils till they have made considerable progress, and should then be made the subject of a special lesson.

Exercise 6.

1. How many *farthings* are worth 4½d.? How many *pence* are worth 7s. 3d.? How many are worth 3s. 7d.? How many are worth 3s. 4d.? How many *farthings* are worth 40d.? How many are worth 3s. 4½d.?

2 How many *shillings* are worth £1, 10s.? How many are worth £2, 10s.? How many are worth £6, 5s.? How many are worth £2, 3s.? How many *pence* are worth 35s.? How many are worth £2, 13s.? How many are worth £2, 13s. 4d.? How many *farthings* are worth 44s. 2d.? How many are worth £2, 18s. 6d.? How many are worth £1, 5s. 4¾d.?

N.B.—*From such Exercises as these, deduce the Rule for Reduction to terms of a Lower Denomination.*

3. Add together 8, 17, 107, and 94, and reduce the sum by 26.

4. How many must be added to 9 times 25 to make it 270?

5. Find a number which being increased by 17, and then divided by 2, gives a quotient of 18.

6. A man had a certain number of hens; one day they all laid an egg except one; the next day 2 died, and one did not lay. If he thus obtained 18 eggs in the two days, how many fowls had he at last?

7. The area of a rectangular field was 30 roods 10 poles. If it was 40 yds. wide, how long was it? [Express answer in poles.]

8. The circumference of a circle being $\frac{22}{7}$ of its diameter, what is the length of the radius of a circle whose circumference is 14 yds. 2 ft.?

9. If $1\frac{1}{2}$ lb. of beefsteak cost 1s. $4\frac{1}{2}$d., what is the cost of 5 lb.?

10. How many sq. ft. of paving are required for a court which is 21 yds. long and 40 ft. wide?

11. At 10s. a sq. yd., what will be the cost of paving a court which is 42 ft. square?

12. How many gallons of oil at 2s. 4d. per gallon are worth 16s. 4d.?

13. How many gallons of oil at 3s. 1d. per gallon are worth 111 lb. of sugar at 5d. per lb.?

14. How much tea at 2s. 10d. per lb. is worth as much as 17 gallons of wine at 10s. 6d. per gallon?

15. How many ounces of isinglass at $11\frac{1}{2}$d per oz. must be given in exchange for $1\frac{1}{2}$ lb. of tea at 8s. $9\frac{3}{4}$d. per lb.?

16. Take 47 from 105 and divide 290 by the remainder.

17. How many ounces of tea are equal in weight to $11\frac{1}{2}$ lb. of coffee?

18. And, if tea be 3 times as dear as coffee, how many ounces of coffee are worth $6\frac{3}{4}$ lb. of tea?

Exercise 7.

1. How many *eighths* make a unit? How many make three-quarters of a unit? How many *twentieths* make $\frac{3}{4}$? How many are equal to $3\frac{1}{2}$? to $7\frac{1}{4}$? How many *sixths* make $13\frac{3}{3}$?

2. How many units are equal to 40 *fifths*? How many to 132 *twenty-fourths*? Express otherwise 7 *thirds* and $\frac{4}{7}$.

3. Add together $4\frac{1}{3}$ and $3\frac{1}{12}$; $7\frac{2}{5}$ and $4\frac{3}{10}$; 108, $2\frac{1}{2}$, and $\frac{17}{18}$.

4. Find the value of $8 - 2\frac{1}{7}$; $19\frac{3}{5} - 2\frac{7}{12}$; $4\frac{1}{3} - 2$; $2\frac{2}{11} - \frac{3}{7}$.

5. Divide $16\frac{3}{5}$ by 5; $20\frac{5}{17}$ by 5; $108\frac{12}{109}$ by 6.

6. Multiply $17\frac{1}{7}$ by 4; $19\frac{3}{17}$ by 10; $201\frac{101}{102}$ by 3.

7. What is the value of $4\frac{4}{15}$ acres of land at £27, 6s. per acre?

8. How many sq. yd. of land are contained in a garden which measures 84 ft. by $10\frac{2}{3}$ yd.?

9. If Mont Blanc be 15720 ft. in height, express that height in *miles* and *yards*; and also in *miles and fractions of a mile.*

10. The price of $2\frac{1}{2}$ lb. of butter being 2s. 6d., how many ounces of butter can be bought for 8s. 3d.?

11. How many yards of silk are worth £31, 5s., if £5·25 be the cost of $10\frac{1}{2}$ yards?

12. Reduce £4, 3s. $5\frac{1}{4}$d. to farthings.*

13. The cost of 320 yd. of calico at $2\frac{3}{4}$d. per foot is——?

14. What length of cloth at 7s. 6d. per yard can be purchased for £37, 10s.?

15. A newsboy receives 25 dozen papers to sell, there being 13 copies to the dozen. His remuneration is to be $\frac{1}{10}$ of the receipts supposing there to be only 12 copies to the dozen, and all he can get for the remaining copies. Supposing him to sell the lot at 2d. each, how much money does he get for himself?

16. The daily wages of A being half as much again as that of B, what will A receive for 24 days' work if B receive £5 for working 16 days?

17. The areas of circles vary as the square of their diameters; if the area of a given circle be $3\frac{3}{5}$ sq. yd., what will be the area of another circle whose diameter is 5 times longer than the former one?

18. How many must be added to the product of 9 times 21 to make it equal to 9 times 22? Find a rule for working such a sum as this.

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* Remember that 1000 pence = £4, 3s. 4d.

CHAPTER IV.

RULES FOR MENTAL ARITHMETIC.

8. DISCIPLINE OF THE MIND IN ACQUIRING THESE RULES.

In teaching the following Rules to children, the teacher should remember that he may materially increase the *intelligence* of his pupils by leading them to deduce these Rules in a manner similar to that described in Chapter III. For example—

Let it be required to teach children how to multiply by 25.

The teacher will proceed to use such "Inductive Questioning" as here follows—

(1.) *What is the shortest method of multiplying by* 10? *Answer*, Annexing a cipher to the multiplicand.

(2.) *If then you annex* TWO *ciphers to the multiplicand, by what number will you have multiplied it? Answer*, A hundred.

(3.) *What number is half-a-hundred? A quarter-of-a-hundred? If a hundred be divided by* 4, *what is the quotient? Then, what is the value of* $\frac{100}{4}$?

(4.) *If then I am required to multiply a number by* 25, *and, instead of doing that, I multiply it by* 100, *what must I do to the product to obtain the true answer?*

(5.) *Then, it seems that* $37 \times 25 = \frac{37 \times 100}{4}$; *is it so? What Rule, then, have we found for multiplying a number by* 25?

N.B.—If the children are pretty well acquainted with fractions, the Rule so *found* may be *confirmed*, thus—

$$37 \times 25 = 37 \times \frac{100}{4} = \frac{37 \times 100}{4} = \frac{3700}{4}.$$

9. RULES FOR MULTIPLICATION—CALCULATIONS OF COST.

RULE 1.—To multiply a number by 10, annex a cipher to the right of it.

Ex. $236 \times 10 = 2360$.

RULE 2.—To multiply a number by 100, annex TWO ciphers to the right of it.

Ex. $236 \times 100 = 23600$.

Exercise 8.

1. Multiply 16, 47, 305, 873, 207, and 61003 each by TEN.

2. Multiply 19, 73, 650, 8050, 17901, and 40700 each by ONE HUNDRED.

3. Find the value of $7\frac{1}{2} \times 10$; $\frac{1}{3}$ of $16\frac{1}{2} \times 10$; 7 times $16\frac{1}{2}$ times 10.

4. Simplify $3\frac{1}{2} \times 100$; $2\frac{3}{4} \times 100$; $100 \times 6\frac{1}{4}$; 800 by $5\frac{1}{2}$; 62×300.

5. Find Rules for multiplying a given number by 1000, by 10000, and by 100000, and apply them to find the value of 131×1000; 273×10000; 8049×100000; 10000×67; 100000×208; 97×20000; 605×3000.

6. What is the value of $14\frac{1}{2} \times 60$; $18\frac{3}{5} \times 800$; $104\frac{1}{10} \times 6000$; 1800×650;* 2400×325; 750×3200; $19\frac{1}{4} \times 24000$.

7. What is the area of a rectangle whose length is 16 ft. and width $2\frac{1}{2}$ ft.?

8. What is the cost of 100 lb. of sugar at $6\frac{1}{2}$d. per lb.?

9. If 1 ft. of timber cost $7\frac{1}{2}$d., what is the cost of $33\frac{1}{3}$ yd. (Linear Measure)?

RULE 3.—To multiply a number by 25, annex TWO ciphers to the right of it, and divide the result by 4.

Ex. $64 \times 25 = \frac{6400}{4} = 1600.$

The reason of this Rule† is that $25 = \frac{100}{4}$.

RULE 4.—To multiply a number by 125, annex THREE ciphers and divide by 8.

Ex. $64 \times 125 = \frac{64000}{8} = 8000.$

The reason of this Rule† is that $125 = \frac{1000}{8}$.

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* $1800 \times 650 = \frac{1800}{2} \times (2 \times 650) = 900 \times 1300 = 90000 \times 13.$

† It will be necessary to remind the teacher that he should be careful to ask a good many inductive questions before pointing out any of the Rules here given. See § 8. In fact, the reason of the Rule must precede the statement of the Rule itself.

RULE 5.—To multiply a number by $12\frac{1}{2}$, annex TWO ciphers and divide by 8.

Ex. $64 \times 12\frac{1}{2} = \frac{6400}{8} = 800.$

The reason of this Rule is that $12\frac{1}{2} = \frac{100}{8}$.

Other Examples.

Ex. 1. *Find the value of* $135 \times 11\frac{1}{9}$.

Since $11\frac{1}{9} = \frac{100}{9}$, *the Answer* $= 135 \times \frac{100}{9} = \frac{13500}{9} = 1500.$

Ex. 2. *Find the value of* $1\frac{1}{4} \times 624$.

Since $1\frac{1}{4} \times 624 = 624 \times 1\frac{1}{4}$, and $1\frac{1}{4} = \frac{5}{4} = \frac{10}{8}$,

The Answer $= 624 \times \frac{10}{8} = \frac{6240}{8} = 780.$

Ex. 3. *Find the cost of* 108 *articles at* £3, 6*s.* 8*d. each.*

Since £3, 6s. 8d. $= £3\frac{1}{3} = £\frac{10}{3}$,

The Answer $= £\frac{10}{3} \times 108 = £108 \times \frac{10}{3} = £\frac{1080}{3} = £360.$

Ex. 4. *Find the cost of* 36 *articles at* £12, 10*s. each.*

The cost of 36 articles at £100 each = £3600. But £12, 10s. $= £\frac{100}{8}$.

∴ The cost of 36 articles at £12, 10s. each $= £\frac{3600}{8} = £450$, *Ans.*

Ex. 5. *Find the cost of* 728 *articles at* £1, 5*s. each.*

Since £1, 5s. $= £1\frac{1}{4} = £\frac{5}{4} = £\frac{10}{8}$, *the Answer* $= £\frac{7280}{8} = £910.$

Exercise 9.

1. Find the value of 83×100; 177×1000; $25\frac{1}{2} \times 2000$; $17\frac{1}{2} \times 500$.

2. Multiply 808 by 25, 960 by 125, and 84 by $12\frac{1}{2}$.

3. Simplify the following:—$\frac{80500}{8}$; $\frac{163200}{16}$; $\frac{90300}{11}$; $\frac{5281000}{9}$.

4. Find the value of £1, 5s. × 32; £12, 10s. × 96; £3, 6s. 8d. × 72; £12, 10s. × 440; £2, 10s. × 176; £3, 6s. 8d. × 99.

5. Find the product of 18 and 25; 163 and 25; 207 and 25; 38 and 125; 69 and 125; 55 × 125; 14 × 12½; 780 × 12½.

6. Find Rules for calculating the cost of a given number of articles at £1, 13s. 4d., £16, 13s. 4d., and £8, 6s. 8d., and apply them to find the cost of 102 articles at £1, 13s. 4d.; 84 articles at £16, 13s. 4d.; 132 articles at £8, 6s. 8d.

7. If the cost of 3 tons of coal be £5, how much coal may be bought for £85?

8. What does a man earn in 48 days if his wages be 12s. 6d. per day?

9. When £8, 6s. 8d. is the cost of 5½ tons of sugar, what is the price of 132 tons of sugar at the same rate?

10. How many times may £1, 5s. be taken from £100?

11. How many times does 1025 contain 25?

12. How many times is £8, 6s. 8d. contained in £150?

13. How many allotments of land, each containing 12 acres 2 roods, may be made out of a field containing 125 ac.?

Exercise 10.

1. Multiply 63 by 25; 709 by 250; 183 by 2500; 37 by 2½.

2. Find the value of 108 × 12½; 77 × 2½; 106 × 125; 377 × 1250.

3. If an acre of land be worth £79, what is the value of 8½ acres?

4. How much cloth can be purchased for £75 when 100 yards cost £125?

5. By how many must the product of 17 times 250 be reduced to leave a remainder equal to 160 times 12½?

6. How many times will a hoop turn in travelling 2½ miles if it is 44 inches in circumference?

7. A gallon of wine being worth 16 quarts of ale, how many gallons of ale are worth 73 galls. 2 qts. of wine?

8. If a man can do as much in 3 days as a boy can in 5, how many days will a boy be employed in doing a piece of work which a man could do in 24 days?

9. If 8 women can do as much as 25 boys, how long will it take a boy to do a piece of work which a woman can do in 96 hours?

10. If a man and a woman work together for 16 days, what will the

sum of their wages be, supposing the man earns 8s. 1d. per day, and the woman 4s. 5d. per day?

11. What is the value of 160 cottages at £125 each?

12. The price of 19 straw hats is £6, 6s. 8d., what would be the price of 25 times that number?

13. A contractor engaged to perform a piece of work in 70 days, and to forfeit 5s. for each day after that time that the work remained unfinished. On the other hand, he was to receive 2s. 6d. extra for every day occupied in the work less than the 70 he agreed upon. When the work was finished he received £3, 15s. more than he would have received if he had been as many days *behind* time as he was really *before* time in finishing. How long was he engaged upon the work?

RULE 6.—To multiply a number by 625, annex FOUR ciphers and divide by 16.

Ex. $96 \times 625 = \frac{960000}{16} = 60000.$

The Reason of this Rule is that $625 = \frac{10000}{16}$.

Exercise 11.

1. Find Rules for multiplying a given number by $6\frac{1}{4}$, by $62\frac{1}{2}$, by 6250, by 62500, &c.

2. Find Rules also for calculating cost at £625, £62, 10s., £6, 5s., &c., deducing them from the foregoing Rules for Multiplication.

3. Find the value of 848×625; 625×192; 1120×625; 3800×625; 917×625; 625×402; 625×709.

4. Multiply 896 by 6250; 7520 by 62·5; $656 \times 6\frac{1}{4}$; $256 \times 62\frac{1}{2}$; $62{\cdot}5 \times 176$; $6\frac{1}{4} \times 3216$; $7340 \times 6\frac{1}{4}$; $8972 \times 62\frac{1}{2}$.

5. Find the price of 284 articles at £62, 10s. each; of 352 at £6, 10s. each; of 625 at £176 each; of $62\frac{1}{2}$ at £904 each.

6. How many articles at 1s. each are worth 108 at £31, 5s. each?

7. What number of newspapers at 1d. each are worth as much as 160 books at 5s. $2\frac{1}{2}$d. each?

8. A person buys newspapers at $\frac{3}{4}$d. each, and sells them at 1d. each; how many must he sell to be able to buy 336 magazines at $6\frac{1}{4}$d. each, with the profits?

9. A square platform is found to measure 52 ft. 3 in. in front; express its area in square inches.

10. What number of nuts must have been divided among 625 school children if each received 53?

11. What is that number which being divided by 976 gives 6250 for its quotient?

12. How many cubic inches of water were contained in a barrel from which there leaked daily 62½ cubic inches, and was thereby half emptied in 41 days?

Exercise 12.

1. From Rule 6 derive Rules for multiplying by 312½, by 3125, by 31250, by 31¼, &c., &c., and consider how, from these,* methods may be derived for calculating costs at £312, 10s., at £3125, at £31, 5s., at 31s. 6d. (*i.e.*, 31½s.), at £156, 5s. (*i.e.*, 3125s.), &c., &c.

2. Find the value of 352 × 3125; 3125 × 384; 544 × 3125; 224 × 312½; 312·5 × 672; 31¼ × 992; 512 × 31·25.

3. Find the value of 32 articles at £312, 10s. each; of 160 at £31, 5s. each; of 648 at £3, 2s. 6d. each; of 312½ at £192 each.

4. What is the value of 748 pictures at 6s. 3d. each?

5. What annual income does a man derive from the rent of 83 houses rented at £32 a year, from which, however, 15s. is deducted by each tenant for house-duty?

6. How far does a train travel to make one of the wheels of the engine turn 480 times, its circumference being 31 ft. 3 in.? If the circumference of the wheel had been 26 ft. 0½ in., how far would the train have travelled? [Express the first answer in *feet*, the second in *inches*.]

7. What number must be divided by 817 to give 3125 for a quotient?

8. What is the least number which must be taken from the product of 19 times 312·5 to leave a remainder exactly divisible by 100?

9. How many square metres of area are bounded by 288 curbstones each 31 metres 25 centimetres in length, if the space surrounded be a rectangle twice as broad as it is long?

10. A piece of carpet is half as long again as it is broad. If the distance round it be 312 ft. 6 in., what is its area in sq. ft.?

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* The teacher may further require his pupils to find rules for multiplying by other numbers, such as 3·125, ·3125, &c., &c. The mere *finding the Rule* will form an intelligent Exercise even though it may not be applied to the working of Exercises.

11. The length of a table is 7 ft. 1 in., being 5 in. in length for every 3 in. in breadth. Express in sq. in. the surface of the table.

12. The area of a billiard-room is the same as that of a coffee-room which is 30 ft. long and 17 ft. 6 in. broad. In the former it is also found that for every 7 ft. in length it is 3 ft. in breadth. Express in *feet* its length and breadth.

10. RULES FOR DIVISION.

1. Since any given number may be *multiplied* by 10 by annexing a cipher to its right, it follows that

RULE 1.—Any given number may be divided by 10 by placing a dot (*decimal point*) between the two figures on its right.

Ex. $640 \div 10 = 64{\cdot}0 = 64.$

$7381 \div 10 = 738{\cdot}1 = 738\frac{1}{10}.$

2. Since $25 = \frac{100}{4}$, it follows that

RULE 2.—Any given number may be divided by 25 by multiplying it by 4, and then placing a decimal point between its second and third figures, counting from the right.

Ex. $283 \div 25 = 283 \div \frac{100}{4} = 283 \times \frac{4}{100} = \frac{283 \times 4}{100}$

$= \frac{1132}{100} = 11{\cdot}32.$

Exercise 13.

1. How do you divide a number by 100? by 200? by 300? by 400? Apply these Rules to find the value of $363 \div 100$; $751 \div 200$; $7839 \div 300$; $1668 \div 400$; $73596 \div 200$; $200817 \div 300$.

2. What two Rules could you give for dividing a number by 500? Find by them the cost of land per acre when 500 acres cost £216000; and the prize-money which each soldier receives when £18750 are divided among 500 men.

3. Multiply 642 by 100, and divide 80600 by 100; find the value also of $893 \div 100$, and of $247{\cdot}3 \div 100$.

4. Multiply 705 by 100, divide it also by 100, and find the *difference* between the two results.

5. How much can a boy earn per day supposing the wages of 200

boys for $2\frac{1}{2}$ days to be 1750 shillings? Find at least three ways of doing this sum.

6. Forty-four men can do a piece of work in 25 days, how many men could do it in a day?

7. A rectangular field is 25 yds. long, and contains 1175 sq. yds.; what is its width?

8. The floor of a room contains 841 sq. yds.; if its width be 75 feet, what is its length?

9. The number of cubic feet of air contained in a room which is 25 feet high is found to be 19075. What is the area of the floor?

10. Divide 441 by 600; 778 by 900; and 345 by 1100; 5117 by 1700; 2678 by 1300; 900540 by 180; 420630 by 21000.

11. What is the cost of 10 bags of potatoes, each containing 112 lb. at 25d. for 10 lb.? [Express the answer in *pence.*]

12. Multiply 847 by 11, and divide the product by 100.

13. Divide 935 by 100, and multiply the quotient by $12\frac{1}{2}$.

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3. Since $125 = \frac{1000}{8}$, it follows that

RULE 3.—Any number may be divided by 125 by multiplying it by 8, and then cutting off three figures on the right of the product as decimals.

Ex. $3729 \div 125 = 3729 \div \frac{1000}{8} = 3729 \times \frac{8}{1000} = \frac{3729 \times 8}{1000} = \frac{29832}{1000} = 29{\cdot}832.$

Other Examples.

Ex. 1. *Find the value of* $18700 \div 12\frac{1}{2}$ [*or* $12{\cdot}5$].

$$\text{Since } 12\tfrac{1}{2} = \frac{100}{8},$$

$$\textit{The Answer} = 18700 \div \frac{100}{8} = 18700 \times \frac{8}{100} = 187 \times 8 = 1496.$$

Ex. 2. *Find the value of* $648 \div 8\frac{1}{3}$ [*or* $8{\cdot}\dot{3}$].

$$\text{Since } 8\tfrac{1}{3} = \frac{100}{12},$$

$$\textit{The Answer} = 648 \div \frac{100}{12} = 648 \times \frac{12}{100} = \frac{648 \times 12}{100} = \frac{7776}{100} = 77{\cdot}76.$$

Ex. 3. *Find the value of* $231 \div 11\frac{1}{9}$ [*or* $11{\cdot}\dot{1}$].

$$\text{Since } 11\tfrac{1}{9} = \frac{100}{9},$$

$$\textit{The Answer} = 231 \div \frac{100}{9} = 231 \times \frac{9}{100} = \frac{231 \times 9}{100} = \frac{2079}{100} = 20{\cdot}79.$$

Ex. 4. *Find the value of* $27 \div 1\frac{1}{4}$ [*or* $1{\cdot}25$].

$$\text{Since } 1\tfrac{1}{4} = \frac{5}{4} = \frac{10}{8},$$

$$\textit{The Answer} = 27 \div \frac{10}{8} = 27 \times \frac{8}{10} = \frac{27 \times 8}{10} = \frac{216}{10} = 21{\cdot}6.$$

Ex. 5. *Find the value of* $34 \div {\cdot}8\dot{3}$.

$$\text{Since } {\cdot}8\dot{3} = \frac{5}{6} = \frac{10}{12},$$

$$\textit{The Answer} = 34 \div \frac{10}{12} = 34 \times \frac{12}{10} = \frac{34 \times 12}{10} = \frac{408}{10} = 40{\cdot}8.$$

Ex. 6. *How many articles at* £3, 6*s.* 8*d. each are worth* £430?

$$\text{Since £3, 6s. 8d.} = £3\tfrac{1}{3} = £\frac{10}{3},$$

$$\textit{The Answer} = 430 \div \frac{10}{3} = 430 \times \frac{3}{10} = 43 \times 3 = 129.$$

Ex. 7. *How many men can each receive* £6, 5*s. out of a sum of* £1700?

$$\text{Since £6, 5s.} = £6\tfrac{1}{4} = £\frac{25}{4} = £\frac{25 \times 4}{4 \times 4} = £\frac{100}{16},$$

$$\textit{The Answer} = 1700 \div \frac{100}{16} = 1700 \times \frac{16}{100} = 17 \times 16 = 272.$$

Exercise 14.

1. What is the value of $\frac{3}{4}$ of £960, 16s.?
2. Divide 3600 by 25, and multiply the answer by 7.
3. Multiply 17 by 11, add 13 to the product, and divide the sum by 25.
4. How many cows worth £25 each are worth 75 donkeys at £8 each?

5. If 3 yd. 1 ft. of cloth cost £2, 12s. 6d., what was the price per yd.?

6. The price of 10 dozen and 5 flower-pots being 218·75 pence, what was the price of 1 pot? and what was the price of a dozen?

7. What number must be multiplied by 125 to produce 13125?

8. Twelve tons and a half of coal cost £20; what is the price per ton?

9. In 8 hours 20 minutes a man walks 56300 yds.; how many yds. would he walk in 1 hour? how many in 10 hours?

10. A man works 10 hours a day at 5s. 5d. per day; how many hours overtime did he make in a day when he received 6s. 6d. for his day's work, supposing overtime to be paid at double the ordinary wages?

11. Overtime being paid as in the last Exercise, what is the ordinary daily wage of a man who receives 7s. 11d. for a day's work of $8\frac{1}{2}$ hours, his ordinary working "day" consisting of 7 hours only?

12. The cost of 11 yd. 4 in. of brick-wall being £1, 13s. 4d., how many pence would pay for 10 yd.?

13. Find the difference between 25 times $\cdot 8\dot{3}$ of 602, and 300 times $\frac{5}{6}$ of 301. Work this Exercise by as many methods as you can.

14. How many sheep, each worth £6, 13s. 4d., can be bought with £7500?

Exercise 15.

1. Multiply 4084 by 25, reduce the product by 2000, and divide the remainder by 1001.*

2. Divide 323100 by 125.

3. Find how many times 1250 can be taken from 971250.

4. What number is the same part of 243 that $11\frac{1}{9}$ is of 100?

5. Find the cost of 9 dozen Science Primers at $7\frac{3}{4}$d. each.

6. If a bookseller spends £100 for books, and sells them for £125, how much ought he to gain on another lot which cost him £76, profit being the same as before?

7. A merchant buys goods for £1000, and sells them for £1125; what profit does he make on an outlay of £1768?

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* If the children are young, the teacher should divide this question into *three*, putting them to the class one after the other as fast as they find the answer.

8. How many oranges at 1½d. each are worth 2s. 1d.?

9. How many pairs of trousers at 24s. per pair can be bought for £85, 4s.?

10. How many times must $2\frac{1}{2}$ be taken to make up 85?

11. If 8 glass marbles be considered worth 25 stonies, how many of the former are worth 925 of the latter?

12. Apples being 4 a penny, and oranges a penny each, how many children can be supplied each with an orange and an apple by spending 1s. 3d.

13. At a school-treat the dinners cost a shilling each, while the teas were at the rate of seven for three shillings. How many took dinner and tea if the total cost was twenty guineas?

11. RULES FOR CALCULATIONS OF COST.

1. Since 2s. 6d. = $\frac{1}{8}$ of £1,* we find that

RULE 1.—The cost of any number of articles at 2s. 6d. each may be found by dividing that number by 8 and calling the quotient POUNDS.

Ex. *The price of 72 articles at 2s. 6d. each* = $£\frac{72}{8}$ = £9.

N.B.—The truth of this result may be further shown, thus—

The price of 72 articles at £1 each = £72.

∴ *The price of 72 articles at £$\frac{1}{8}$ each* = $£\frac{72}{8}$ = £9.

Such Exercises as these form an excellent preparation for "PRACTICE," and the teacher should be careful to explain the "*truth of the result*" in some such way as is here exemplified.

2. Since 7s. 6d. = 3 times 2s. 6d., it follows that

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* The children should be made to find this out, thus:—(1.) What is a *sovereign?* (2.) How many shillings are worth *half-a-sovereign?* (3.) What is the half of 10s.? (4.) What name have we for 5s.? (5.) If 5s., then, be a *crown*, how many crowns are worth £1? (6.) What is the value of *half-a-crown?* (7.) How many crowns did you say were worth £1? (8.) Then, how many half-crowns are worth £1? &c., &c.

RULE 2.—The cost of any number of articles at 7s. 6d. each may be found by dividing that number by 8, calling the quotient POUNDS, and then multiplying it by 3.

Ex. *The price of* 48 *articles at* 7*s.* 6*d. each* $= £\frac{48}{8} \times 3$ $= £6 \times 3 = £18.$

Exercise 16.

1. What is the price of 72 fowls at 2s. 6d. each?
2. Find the value of 1 cwt. of tea at 2s. 6d. per lb.
3. Find a Rule for calculating the cost of any number of articles at 3s. 4d. each, and apply it to find the value of 7 dozen oil-lamps at 3s. 4d. each.
4. How many articles at half-a-crown each could be bought for £31?
5. How many new caps at 3s. 4d. each could be bought with £51?
6. How many half-crowns are worth £3, 10s.? How many are worth £1, 10s.?
7. If a man earns 3s. 4d. a day, and a woman earns 2s. 6d. a day, how many women can earn as much as 36 men?
8. Find the wages of 73 women for 16 days at 2s. 6d. a day, and that also of 91 men for 48 days at 3s. 4d. per day.
9. How many mirrors at £1 each are worth 104 chairs at 5s. each?
10. How many Bibles at 3s. 4d. each cost as much as 88 Church Services at 10s. each?
11. A bag of manure is worth 3s. 4d.; how many bags are worth £8, 6s. 8d.?
12. A pound of butter and a pound of tea cost together 3s. 4d.; how much must a gentleman spend if he wishes at Christmas to give 2 lb. of butter, and 2 lb. of tea, and 5s. in money to each of 24 old people?
13. A gentleman provided all the old men in a workhouse with 2 ounces of tobacco each, at 3½d. an ounce, one Christmas; and to the old women he gave a tea which cost him 13d. each. It was found that there were 36 old men and the same number of old women who received his bounty; how much did his kindness cost him?

3. The pupil should here become acquainted with the following "**Aliquot Parts of a Pound**:"—

10s. = £$\frac{1}{2}$.	6s. 8d. = £$\frac{1}{3}$.	4s. = £$\frac{1}{5}$.
5s. = £$\frac{1}{4}$.	3s. 4d. = £$\frac{1}{6}$.	2s. = £$\frac{1}{10}$.
2s. 6d. = £$\frac{1}{8}$.	1s. 8d. = £$\frac{1}{12}$.	8d. = £$\frac{1}{30}$.
1s. 3d. = £$\frac{1}{16}$.	10d. = £$\frac{1}{24}$.	1s. 4d. = £$\frac{1}{15}$.

These should all be taught the pupils as in Chapter I. When these have been thoroughly learnt, the pupils may be led on to the study of Calculations of Cost at such prices as—

6s. 3d., *which is equal to* 5 *times* 1s. 3d., *i.e.*, £$\frac{5}{16}$, *i.e.*, £$\frac{10}{32}$;

£1, 13s. 4d., *which is equal to* £1$\frac{2}{3}$, *i.e.*, £$\frac{5}{3}$, *i.e.*, £$\frac{10}{6}$,

8s. 4d., *which is equal to* £$\frac{5}{12}$, *i.e.*, £$\frac{10}{24}$,

£1, 4s., *which is equal to* £1$\frac{1}{5}$, *i.e.*, £$\frac{6}{5}$, *i.e.*, £$\frac{12}{10}$.

[See Chapter IV, § 9.]

Examples.

Ex. 1. *Find the cost of* 260 *articles at* £1, 6*s. each.*

Here £1, 6s. = £1$\frac{3}{10}$ = £$\frac{13}{10}$.

Now, the cost of 260 articles at £1 each = £260;

∴ The cost of 260 articles at £$\frac{13}{10}$ each = $\frac{13}{10}$ of £260 = £$\frac{260 \times 13}{10}$

= £26 × 13 = **£338** *Answer.*

Ex. 2. *Find the cost of* 144 *articles at* 4*s.* 2*d. each.*

Since 4s. 2d. = 5 times 10d. = 5 times £$\frac{1}{24}$ = £$\frac{5}{24}$ = £$\frac{10}{48}$,

The Answer = $\frac{10}{48}$ of £144 = 10 times £3 = **£30.**

Exercise 17.

1. What is the value of 345 novels at 1s. 4d. each?

2. How many tons of coal at £2, 10s. a ton are worth £870?

3. How many gallons of ale at 2s. 6d. per gallon are worth 624 gallons of rum at 6s. 8d. per gallon?

4. How many pounds of butter at 1s. 8d. per pound can be bought for £3, 1s. 8d.?

5. The cost of 264 sacks of potatoes at 8s. 4d. per sack =

6. How many overcoats at £2 each are worth 70 suits of clothes at £3, 6s. 8d. each?

7. Find the value of 110 acres of land at £3, 4s. per acre.

8. The cost of 1080 feet of gas at 1s. 4d. per foot =

9. How much money will pay for 330 cwt. of salt at 9s. 4d. per cwt.?

10. A school-treat costs, on an average, 3s. 4d. per child; how many children could be entertained in this way for £70, 10s.?

11. What will be the cost of 77 new bonnets at 12s. 6d. each?

12. Find the cost of 108 new dresses at £1, 13s. 4d. each.

13. A bookseller buys 907 novels at 1s. 10½d. each, and sells them at 3s. 1½d. each; what does his profit amount to when all are sold?

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4. ADDITIONAL EXAMPLES.

Ex. 1. *Find the value of* 32 *silver watch-guards at* £1, 1s. *each.*

The price of 32 at £1 each = £32;
and, the price of 32 at 1s. each = 32s. = £1, 12s.
∴ the price of 32 at £1, 1s. each = £32 + 32s. = £33, 12s.

Ex. 2. *Find the cost of* 32 *lb. of tea at* 2s. 7½d. *per lb.*

Here, we find that 2s. 7½d. = 2s. 6d. + $\frac{1}{20}$ of 2s. 6d.

And, the price of 32 at 2s. 6d. each = £$\frac{32}{8}$ = £4.

But, since 1½d. = $\frac{1}{20}$ of 2s. 6d., it follows that
the price of 32 at 1½d. = $\frac{1}{20}$ of the price of 32 at 2s. 6d.
i.e., = $\frac{1}{20}$ of £4.

Now $\frac{1}{20}$ of ONE *pound* = ONE *shilling*,

therefore $\frac{1}{20}$ of FOUR *pounds* = FOUR *shillings.**;

therefore the *Answer* = £4 + 4s. = £4, 4s.

From this we derive the following

RULE for CALCULATING the Cost of any number of Articles at 2s. 7½d. each.

Divide the given number of articles by 8, call the quotient POUNDS (*i.e., find the cost of the given number of articles at 2s. 6d. each*), and add to the result a SHILLING for every POUND contained therein.

The answer to the above example is found by this Rule thus—

$$Answer = £\frac{32}{8} + \frac{32s.}{8} = £4 + 4s. = £4, 4s.$$

Ex. 3. *What is the cost of 72 quarts of wine at 2s. 7½d. per quart?*

By the RULE,

$$The\ Answer = \left(£\frac{72}{8}\ i.e. \right) £9 + 9 \text{ shillings} = £9, 9s.$$

Ex. 4. *Find the value of 56 straw hats at 2s. 4½d. each.*

In this case we have 2s. 4½d. = 2s. 6d. *minus* $\frac{1}{20}$ of 2s. 6d., so that after finding the price of 56 at 2s. 6d., we must *subtract from*, instead of *adding to*, that result a shilling for every pound it contains.

In this way, then, we find that the

$$Answer = \left(£\frac{56}{8}\ i.e. \right) £7 - 7s. = £6, 13s.$$

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* To make this point clear to children, let the teacher proceed thus:—(1.) How many shillings make £1? (2.) How many *twentieths* make *unity?* (3.) What is one-twentieth of £1? (4.) What is one-twentieth of £2? of £3? of £4?

Let him also carefully question out every point in this and every explanation, always endeavouring to lead the children to discover the Rule *for themselves.*

Ex. 5. *Find the cost of* 104 *yards of cloth at* 2*s.* 4½*d. per yard.*

By the method exhibited in Ex. 4, we find

$$Answer = \left(£\frac{104}{8} = \right) £13 \textit{ minus } 13s. = £12, 7s.$$

Examine well the following list of prices, and find Rules for calculating the cost of any number of articles at each price.

(1.) { 5s. 3d. = 5s. + $\frac{1}{10}$ 5s. / 4s. 9d. = 5s. − $\frac{1}{10}$ 5s. } cf. 2s. 7½d. and 2s. 4½d.

(2.) { 7s. = 6s. 8d. + $\frac{1}{20}$ of 6s. 8d. / 6s. 4d. = 6s. 8d. − $\frac{1}{20}$ of 6s. 8d. } cf. 3s. 6d. and 3s. 2d., with 3s. 4d.

(3.) { 1s. 10d. = 1s. 8d. + $\frac{1}{10}$ of 1s. 8d. / 1s. 6d. = 1s. 8d. − $\frac{1}{10}$ of 1s. 8d. } cf. 11d. and 9d., with 10d.

Ex. 6. *What is the cost of* 60 *lb. of cocoa at* 3*s.* 6*d. per lb.**

(1.) By the method of Ex. 5 we find that the

$$Answer = \left(£\frac{60}{6} \textit{ i.e.} \right) £10 + 10s. = £10, 10s.$$

(2.) Since 3s. 6d. = 7 sixpences = $£\frac{7}{40}$, the

$$Answer = 60 \text{ times } £\frac{7}{40} = \frac{7}{40} \text{ of } £60 = £\frac{60}{40} \times 7 = £1, 10s. \times 7 = £10, 10s.$$

(3.) Since the price of TWENTY at ONE *shilling* = ONE *pound*, the price of TWENTY at 3½ *shillings* must be 3½ *pounds;*

∴ the price of (3 *twenties, i.e.*) 60 must be £3½ × 3 = £10½ = £10, 10s.

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* The teacher should exhibit several methods of finding the answer to a given sum whenever he can. Even though it *may* happen that neither of the methods may ever be used in after-life, the teacher must not forget that by leading his children through the clear exposition of the *Reason of any method* he is teaching them to think, thus developing their minds.

Ex. 7. *How much will* 64 *overcoats cost at* £1, 1*s.* 3*d. each?*

The cost of 64 at £1 each = £64;

now £1, 1s. 3d. = £$1\frac{1}{16}$ = £$\frac{17}{16}$;

therefore the *Answer* = $\frac{17}{16}$ of £64 = £$\frac{64}{16}$ × 17 = £4 × 17 = £68.

Exercise 18.

1. Find the value of 53 young pigs at a guinea each.

2. How much money will pay for 54 copies of Longfellow's poems at half-a-guinea each?

3. At 7s. 6d. per dozen, what will be the cost of 8 gross?

4. How many weeks' rent at 2s. 7½d. per week will amount to 8 guineas?

5. If a costermonger buy oranges at 4 for 3 half-pence and sell them at 6d. a doz., how much does he gain on every dozen? and how many oranges must he sell in order to gain 2s. 6d.?

6. At 10s. 6d. per boy per quarter, how much money does a schoolmaster take for instructing 23 boys for a year?

7. It costs 4s. 9d. to print one page of a book, what will the bill be for printing a book of 144 pages?

8. A silversmith buys watches at £2, 4s. 6d. each, and sells them again at £3, 7s. each; how much does he gain on the sale of 120 watches?

9. The poor-rate of the Wandsworth district being 9d. in the pound, what is the total poor-rate collected on a street whose total assessment is £2424?

10. What number of articles at 1s. 8d. each can be obtained for £17?

11. At what price each were 21 chairs sold if the lot cost the buyer £7?

12. Find the price of 306 picture frames at 3s. 6d. each.

13. If a man earns 5s. 2d. per day, and a woman only 3s. 5d., what will be the difference in the amount of their earnings at the end of 12 weeks of 5½ days each?

Exercise 19.

1. If 6s. 7½d. be the price of three pocket-knives, how much shall I have to pay for three dozen?

2. If 7s. 5d. be the value of 5 dozen exercise books, how much shall I receive for 5 gross?

3. A dozen photographs cost 7s. 3d.; what will be the cost of three score at the same rate?

4. Ten dozen and 8 cwt. of coal at 1s. 8d. per cwt.

5. Seven gross and 9 pencil cases at 9d. per dozen.

6. Three tons 2 cwt. of firewood at 7s. per cwt.

7. Three ounces and a half of tobacco at 4s. 8d. per lb.

8. Twenty-two baskets of fruit at 3s. 2d. per basket.

9. The railway fare of a man for a certain distance being 4s. 9d., what will the clerk receive from 42 passengers travelling a distance double the one mentioned?

10. Find the value of 150 scarves at 1s. 10d. each.

11. Multiply 6s. 4d. by 5, and the product by 99.

12. How many bird-cages at 15s. each are worth £18.

13. A bird being worth ⅔ of the value of itself and cage together, and the cage being worth 3s. 9d., what would be the worth of 48 such birds and cages?

5. OTHER EXAMPLES.

Ex. 1. *Find the cost of* 240 *articles at 7d. each.*

Since 240d. = £1, we find that
The cost of 240 articles at **1**d. each = **£1**.
∴ The cost of 240 articles at **2**d. each = **£2**.
And, therefore, in the same way,
The cost of 240 articles at **seven** *pence* must be **seven** *pounds*.
Answer = **£7**.

Ex. 2. *Find the value of* 240 *articles at* 3¾*d. each.*

As in Example 1, we find
The cost of 240 articles at ONE *penny* each = ONE *pound*;
∴ The cost of 240 articles at 3¾ *pence* each = 3¾ *pounds*.
= **£3, 15s.**, *Answer*.

Ex. 3. *Find the cost of* 239 *articles at 5s. 2d. each.*

The cost of **240** at 62 pence (*i.e.*, 5s. 2d.) = £62.

∴ The cost of **239** at 62 pence = £62 − 62d.

= **£61, 14s. 10d.**, *Answer.*

Remember that

£1 = 20s. = 240d. = 480 h.d. = 960 f.

And then find Rules for calculating the cost of

19 at 63s. each.	**479** at 9½d. each
21 at 31s. each.	**481** at 2s. 5d. each.
241 at 7½d. each.	**960** at 3¾d. each.
243 at 1s. 7d. each.	**961** at 5½d. each.
480 at 1s. 7½d. each.	**959** at 8d. each.

Ex. 4. *What is a man's yearly income at 7s. a day?*

At *a penny* a day his yearly income would be 365 *pence.*

But this 365 *pence* is equal to 240d. + 120d. + 5d., which is equal to £1 + (10s., *i.e.*,) £½ + 5d.

Therefore, the year's income at (7s., *i.e.*,) 84 pence per day, will be

(**£1** × 84) + (£½ × 84) + (**5d.** × 84).

= £84 + ½ of £84 + 5 times **7s.**

= £84 + £42 + £1, 15s.

= **£127, 15s.**, *Answer.*

Hence we derive the following Rule :—

RULE.—To find a person's annual income, reduce his daily income to *pence* **and call it** *pounds;* **to this sum add one-half of itself, and further increase the sum so found by 5 times the given daily income.**

Exercise 20.

1. Find the cost of 12 score chickens at 1s. 7d. each.
2. What is the value of 480 reels of cotton at 2½d. per reel?
3. A soldier receives a pension of 6½d. per day; how much does that come to in 2 years and 230 days?
4. What is a person's income a year at 1s. 10d. per day?
5. Find the total cost of 120 skeins of silk at 7d. a skein, and 60 skeins of worsted at 1s. 2d. per skein.

6. A troop of cavalry possess 479 horses; what would be the cost of shoeing them at 6¼d. a foot?

7. A seedsman sells 1920 tulip bulbs at 3 for 2d.; how much does he receive for the lot?

8. What is the cost of 23 boxes of lozenges at 5½d. per box?

9. The cost of 41 pairs of gloves at 3s. 4d. a pair =

10. Fifty-nine yards of velvet at 2s. 11d. a yard =

11. How many ounces of tea at 3¾d. per oz. can be bought for £3, 15s.?

12. How many times is 1¼ contained in 80?

13. How many oranges at 7¾d. per dozen could be bought for £7, 15s. 7¾d.?

Exercise 21.

1. What is the price of 10 packets of tobacco, each containing 1½ lb. at 3½d. an ounce?

2. Crocus bulbs are 8½d. per dozen; what will be the price of sufficient bulbs to fill 12 beds, each bed containing 5 rows of 48 bulbs each?

3. And what would be the price of twice as many snowdrops at 4¾d. a dozen?

4. When cauliflowers are 3¾d. each, what will a gardener receive for 959?

5. How much would he receive for 961 at 2½d. each, if 5 dozen were bruised and so fetched only 2d. each?

6. What is the receipt upon 1920 pots of jam at 6¾d. per pot?

7. A man's wages are 5s. 1d. per day; how much will he receive for working from the first day of June to the last day of July, Sundays included?

8. On Good Friday a baker sells 73 dozen buns at 5½d. per dozen; how much were his total receipts for buns that day?

9. If a box of pills cost a chemist 2d., and he sells them for 1s. 1½d., how much profit will he in this way make in 48 weeks supposing him to sell on an average 5 boxes a week?

10. A butcher buys 2400 lb. of beef at 8½d. a pound; what does he pay for the lot?

11. Eleven and three-quarter pounds of mutton at 10d. a pound =

12. What is the price of a sucking pig which weighs 3¾ lb. at 13d. a pound?

13. How many pints of gin at 1s. 6d. a pint are sold for as much as 100 lb. of tea at 3s. per lb.?

12. PROPORTION.

7 is a *third* of 21, and 5 is a *third* of 15, so that we may say that 7 *bears the same relation to* 21 *that* 5 *does to* 15.

In a similar manner we find that since

44 is *four-fifths* of 55, and 36 is *four-fifths* of 45,
44 *bears the same relation to* 55 *that* 36 *does to* 45;

OR, which is the same thing,

As 44 *is to* 55 *so is* 36 *to* 45. (1.) OR,
44 *is to* 55 *as* 36 *is to* 45. (2.) OR,

by the use of dots (see "*Advanced Arithmetic*," page 162),

44 : 55 :: 36 : 45. (3.)

Such an expression as this (3.) is called a **Proportion**, and we can test the truth of its statement thus—

TEST.—Multiply together the first and last of its numbers (44 and 45); if the product is the same as that of the two middle numbers (55 and 36), the Proportion expresses the truth; if not, its statement is false.

Ex. 7 : 4 :: 56 : 32 is a *True Proportion*, because 7 × 32 gives the same product as 4 × 56; but

5 : 3 :: 22 : 9 is *not* a True Proportion, because 5 × 9 gives a product not the same as 3 × 22.

Now, by an application of the principle involved in this test, when any three terms of a Proportion are given, we can always find the remaining one, thus—

Let the following be a true proportion,

A : B :: C : D
then A × D = B × C,

from which it follows that

$$(1.)\ A = \frac{B \times C}{D} \qquad (3.)\ C = \frac{A \times D}{B}$$

$$(2.)\ B = \frac{A \times D}{C} \qquad (4.)\ D = \frac{B \times C}{A}*$$

Exercise 22.

1. What number bears the same relation to 4 that 21 does to 7?

2. What number is to 20 as 108 is to 27?

3. Find a number which shall contain 35 as many times as 42 does 10.

4. Find a number which shall be contained in 63 as many times as 8 is contained in 42.

5. Find the value of x in the following "*proportions*"†—

(1.)	54	:	7	::	63	:	x	(12.)	27	:	x	::	x	: 3
(2.)	$8\frac{1}{2}$	:	99	::	x	:	144	(13.)	64	:	x	::	x	: 81
(3.)	27	:	36	::	36	:	x	(14.)	x	:	16	::	25	: x
(4.)	x	:	42	::	35	:	49	(15.)	x	:	72	::	50	: x
(5.)	x	:	66	::	31	:	341	(16.)	36	:	48	::	48	: x
(6.)	$2\frac{1}{2}$	:	x	::	$3\frac{1}{4}$	:	$32\frac{1}{2}$	(17.)	85	:	x	::	x	: 340
(7.)	3	:	$10\frac{1}{2}$	::	7	:	x	(18.)	90	:	x	::	$3x$	: 120
(8.)	8	:	x	::	12	:	30	(19.)	30	:	x	::	x	: 270
(9.)	$16\frac{1}{2}$	:	x	::	15	:	45	(20.)	x	:	72	::	50	: x
(10.)	20	:	3	::	51	:	x	(21.)	x	:	31	::	372	: $3x$
(11.)	105	:	45	::	x	:	20	(22.)	$7x$	:	20	::	3500	: x

6. What is the length of the side of a square plot of land which contains as much ground as a rectangular piece 40 yds. wide and 90 yds. long?

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* This does not pretend to give a full explanation of all the points it touches upon; it is meant simply to provide young teachers with some slight guide for early lessons in Proportion. For more details the teacher is referred to the author's "*Advanced Arithmetic*," page 161.

† If the pupils are unacquainted with squares and square roots, omit the right hand column. The teacher should here explain the process of "*cancelling*" (see "*Advanced Arithmetic*," § 59 and 62).

Exercise 23.

1. If a man can earn 10d. while a woman earns 7d., how many men can earn as much as 1050 women?

2. If a woman earns as much in 8 days as a boy does in 11, what will be a boy's wages per week if a woman's be 9s. 2d.?

3. If 3 oz. of tea be worth 1 lb. of sugar, and 28 lb. of sugar cost a guinea, what will be the value of quarter of 1 cwt. of tea?

4. Divide £1, 16s. between Charlie and Fred in the proportion of their ages, the one being 9 yr. and 6 months old, the other 8 yr. and 6 months.

5. By what number must 4 be multiplied in the following "*Proportion*" to make its statement good?

$$45 : 4 :: 81 : 108.$$

6. How many stone of meat at 7s. 6d. a stone are worth 300 lambs at £1 each?

7. What sum of money bears the same relation to 8s. 4d. that 42 does to 105?

8. What number is the same fraction of 102 that 2s. 6d. is of 14s. 2d.?

9. To what sum of money does 3s. 1½d. stand in the same relation that 5⅝ lb. of mutton stands to 1 cwt. of the same meat?

10. What is the numerator of that fraction, whose denominator is 212, and whose value expresses the relation which 17½ oz. troy bear to 2 oz. 13 dwt.?

11. By what number must the denominator of $\frac{7}{11}$ be multiplied to make the fraction express the relation which 6s. 8d. bears to £1?

12. Find the value of x in the following equations—

$$\frac{7}{16} = \frac{x}{49}; \quad \frac{12}{35} = \frac{x}{120}; \quad \frac{x}{44} = \frac{30}{121}.$$

13. One farm contains 14 ac. 2 r., and another contains 20 ac. 2 r.; the cost of draining the two comes to £73, 15s. 10d., and the farmers pay according to the size of their farms; how much has each to pay?

CHAPTER V.

MISCELLANEOUS EXERCISES IN MENTAL ARITHMETIC.

Exercise 24.

1. Add together 8, 16, 72, 35, and 94.
2. Multiply 464 by 25, and increase the product by 73.
3. If a pound of sugar be worth ¼ lb. of coffee, how many pounds of sugar are worth 5½ lb. of coffee?
4. Square 17, add 111 to the result, and divide the answer by 80.
5. A copy-book being worth 3 pieces of black lead, and 9 pieces of black lead being worth 6d., what is the value of a copy-book?
6. What is the price of 3 lb. 5 oz. of cheese at 1s. per lb.?
7. How much money must be given with 17 pigs worth £8 each to pay for 8½ loads of grain at £19 each?
8. Add 16 to 141, and multiply the sum by 9.
9. Take 700 from the continued product of 5, 18, and 1090.
10. If 600 tons of coal cost £900, what is the price of 858 tons?

Exercise 25.

1. Add together 41, 23, and 75, and take forty-nine from the sum.
2. Find the cost of 800 yd. of calico at 3½d. per foot.
3. Oranges being sold at 2 for 1½d., how many may be bought for 1s.?
4. If I buy copy-books at 9 for 2s., and sell them at 9 for 2s. 3d., how much shall I gain on the sale of 9 dozen?
5. The price of 2 cwt 3 qr. of coal being 2s. 9d., what is the price of 1½ tons?
6. What is the price of a dozen herrings when 10½d. is the price of 7?
7. Is 6 times 7 more than 7 times 6? Is 8 times 19 less than 19 times 8? Is 46 times 3½ equal to 3½ times 46? By how many then does five-and-a-half times 16 exceed sixteen-and-a-half times 5?
8. And by how many does 5½ times 14 fall short of 14 times 11?

9. Also, how many must be taken from $8\frac{1}{2}$ times 113 to leave a remainder equal to 113 times $5\frac{1}{2}$?

10. And, once more, how many must be added to 17 times 43 to make it equal to 19 times 44?

Exercise 26.

1. Multiply £2, 3s. $2\frac{1}{4}$d. by 19.

2. Two tons of coal cost £2, 10s.; if one of the tons was half as dear again as the other, what was the cost of the cheaper ton?

3. What is the price of 13 jugs at 1s. 9d. per dozen?

4. The price of 49 reading-books at $7\frac{3}{4}$d. each is ——?

5. Divide 114 by 3, and say how many must be added to 11 times the quotient to make 400.

6. How many sixpences are there in 12 guineas?

7. If a reel of cotton contains 250 yds., how many yards are there on 76 reels?

8. A clock ticks 125 times in 3 minutes, how many minutes will it take to tick 8125 times?

9. Five mince pies cost 1s. $0\frac{1}{2}$d.; how many would cost £1, 0s. 10d.?

10. Instead of multiplying a certain number by 7 I multiplied it by 11, and thus obtained an answer which was too great by 102. What was the true answer?

Exercise 27.

1. Subtract 3018 from 9057, and divide the remainder by 6.

2. To 9060 add 4 times itself, and divide the sum by 10.

3. By what number must 29 be multiplied to give 319 as a product?

4. Find the price of $1\frac{1}{2}$ lb. of tea at 2s. 9d. per lb.

5. If 7 lb. of sugar be worth 13 lb. of salt, how many lb. of salt will be worth 14 lb. of sugar, if salt become twice as dear, and sugar half as dear, as it was at first?

6. A guinea-pig and two rabbits are sold for 3s. 4d.; if the rabbits are 1s. 3d. each, what is half the price of the guinea-pig?

7. What would be the cost of keeping our neighbour's dog "Dash" for three weeks if it costs $2\frac{1}{2}$d. a day for meat, and $4\frac{1}{2}$d. per week for biscuits?

8. What is the amount of the following butcher's bill:—$3\frac{1}{2}$ lb. of

mutton at 1s. per lb.; 1½ lb. of beef suet at 1s. 1d. per lb.; and 5 lb. of beef at 11d. per lb.?

9. I agree to engage a cab for 13 hours at 2s. 7d. per hour; at the end of that time I give the "cabby" 35s.; how much was that in excess of the stipulated fare?

10. When 9 has been added to 13, and the sum has been multiplied by 37, by what number must the product be divided to produce 11 as a quotient?

Exercise 28.

1. Square 21; how many must be added there to make up the square of 30?

2. The cost of 97 articles at 6s. 8d. = ?

3. $5x + y = 16\frac{1}{2}$; if $3y = 12$, what is the value of $7x$?

4. A lamp and a gallon of oil cost 5s. 8d.; the cost of the oil being $\frac{3}{8}$ of the whole, what was the cost of the lamp?

5. A picture cost 7s. 9d.; its price being three-sevenths of that of its frame, what was the price of picture and frame?

6. Find the cost of 17 boxes of gloves at £1, 1s. 6d. per box.

7. Seven men earn three guineas and a half in three days; how much would 9 men earn in 4½ days at the same rate?

8. Divide $\frac{3}{10}\frac{3}{1}$ by $1\frac{2}{3}$.

9. Multiply $3\frac{2}{3}\frac{2}{1}$ by $3\frac{5}{1}\frac{5}{5}$.

10. If one cwt. and a half of salt be worth three quarters of a ton of coal, how much salt is worth 5¼ tons of coal?

Exercise 29.

1. Divide £1, 18s. 3d. by 9.

2. Find the cost of 4030 articles at £1, 6s. each.

3. How many Windsor chairs at 5s. 3d. each can be bought for £64, 1s.?

4. If the railway company charge 10d. for carrying a parcel 93 miles, how far ought they to convey it for 2s. 11d.?

5. The dividend of a certain sum in Division was 10 times the quotient, what was the divisor?

6. A soldier receives a pension of 1s. 3d. a day; how much does that come to in a year?

7. One bad mark cancels three good ones, and Charlie finds that although he has had 7 bad marks during the week he still has 47 good ones remaining. How many good marks would he have if he had had no bad ones?

8. Two milkmen, A and B, supply a street containing 65 houses with 1½d. worth of milk each every day except Sundays. For every two houses supplied by A three are supplied by B; how much money does each take per week from this street? *

9. Divide $9\frac{5}{11}$ by ½ of $1\frac{3}{11}$.

10. How many bottles of port wine at 40s. per dozen should be given in exchange for 20 gallons of sherry at a guinea per gallon?

Exercise 30.

1. Find the value of 17 + 13 + 28.

2. What is the cost of 21 boxes of compasses at 6s. 8d. each?

3. Three horses are sold for £240; the price of one =

4. If 4 oz. of tobacco cost 10d., how much may be bought for 2½d.?

5. Three *pears* cost 1s. 0½d., what was the price of a *pair*?

6. The cost of 11 lb. of butter at 1s. 6d. per lb. =

7. How many penny oranges are worth three dozen mackerel at 6s. 9d. per dozen?

8. 17s. 6d. + £3, 1s. 5d. =

9. From the last answer take £1, 16s. 11½d.

10. Multiply that result by 3.

Exercise 31.

1. Find the cost of 1½ tons of coal at 31s. a ton.

2. The cost of 8 oz. of tea at 3s. 5d. per lb. =

3. And that of 13 oz. at 2s. 8d. per lb. =

4. 809 × 3½ =

5. $6 + 19 + 38 + \frac{105}{3} =$

6. The cost of 7 oz. of snuff at 1s. per lb. =

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* Such a sum as this should be preceded by several preparatory easy ones, and with young beginners the teacher should divide this one itself into two parts.

7. Three pairs of gloves at 2s. 11½d. per pair =

8. Seventeen pairs at 2s. 1d. per pair =

9. Divide the answer by 10.

10. If a man walks 3¾ miles per hour, how far will he walk in 5 hours?

Exercise 32.

1. Find the value of ½ of ⅝ of £1, 7s.

2. Also, of ¾ of ⅝ of £1, 16s.

3. Multiply 3s. 6½d. by 13.

4. The cost of ¾ lb. of cheese at 13d. per lb. =

5. Find the cost of 39 articles at 1s. 5d. each.

6. What is the least number by which 85 must be multiplied to make it a multiple of 30?

7. Multiply 840 by 49.

8. The weight of the head of a fish being ⅛ of its whole weight, which is 75 lb., what is the weight of the body without the head?

9. A whale weighs a thousand pounds more than three-sevenths of its own weight; what *is* its own weight?

10. I buy a garden and give for it a sum of money which is £65 more than three-eighths of itself; what did the garden cost me?

Exercise 33.

1. Multiply 613 by 17.*

2. Multiply £43, 10s. 3¼d. by 28.*

3. By what number was 17 multiplied to give 3621 as a product?

4. If 307 be multiplied by 629 instead of 648, by how many must the product be increased to produce the right answer?

5. Settling accounts with a butcher, a farmer fancies he owes the butcher 9s. 6d., whereas, in fact, the butcher owes the farmer 10 times that amount. Supposing the error not to have been discovered, how much money does the farmer lose by the settlement?

6. A crowd passes a post at the rate of 2½ miles an hour; they walk at an average of 11 abreast, and every 3 rows occupy a yard of space from front to rear. How many pass the post in 4 hours?

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* Such sums as these often occur in the working out of problems on the black-board. Whenever they do occur with the more advanced pupils, let the teacher insist upon having the product found by multiplying *at once* by 17, 28, &c.

7. A rectangular piece of land is 6 times as long as it is wide, and contains 726 sq. yd.; what is its length?

8. A square piece of land is divided into 11 equal and similar rectangular lots, each lot containing 4400 sq. ft.; how wide was each lot?

9. Three horses are worth 8 cows, and 12 cows are valued at £300; what is the value of 7 horses?

10. If a pauper costs the parish 2s. 7½d. per week, what will be added to the rates per year by the drunkenness of a man who brings himself and his wife to the workhouse?

Exercise 34.

1. The cost of 13 brooches at 2s. 6d. each =
2. The value of $40{\cdot}04 \div \dot{2}00\dot{2} =$
3. The value of 1 cwt. of apples at 7d. a lb. =
4. 6¾ lb. of salmon at 2s. 2d. per lb. =
5. A thousand dinners at 6¾d. each cost =
6. A picture frame is 2 ft. wide and ¾ of 2 yd. long, how many linear inches of moulding will be required for 20 such frames?
7. Reduce 3 tons 5 cwt. to lb.
8. Divide 408000 by 2½.
9. Find the value of 2½ times 100 times 603.
10. Multiply 11408 by 625.

Exercise 35.

1. Find the value of 26 half-sovereigns, 18 crowns, and 25 florins.
2. Reduce 2s. 6d. to the fraction of £7.
3. If 1½ lb. of tobacco cost 3s. 6d., what is the price of 1½ lb.?
4. By how many must 4½ be multiplied to make it 11¼?
5. On Easter Monday, 1875, the fare from Battersea to the Crystal Palace was 2s. 1d.; the year before it was only 1s. 6d., and that year we will suppose 42 persons took tickets from Battersea to the palace. How many persons travelled the next year on Easter Monday if the total receipts were 6d. less than the year before?
6. Multiply 60 by 90, and reduce the product by 12 times 85.
7. If cauliflowers are 2½d. each, how many could be bought for *five* guineas?
8. How many grains are there in 2⅛ lb. troy?

9. In one *mile* how many *feet*?

10. Travelling by train on Easter Monday I heard a young woman complain that the booking clerk had overcharged her by 4d., and I remarked that the real fare was to the fare charged as 21 is to 22; what was the real fare?

Exercise 36.

1. What number must be added to 315 to make it equal to 4 times 212?

2. If a clock gains $1\frac{1}{2}$ min. an hour, what will be the right time when the clock indicates a quarter past 7, if it indicated true time at 9 o'clock previously?

3. When eggs are 2s. 1d. a score, how many could be purchased for 12s. 6d.?

4. The weight of one book being $\frac{1}{8}$ oz., how many will be equal in weight to 5 lb. of paper?

5. Multiply 410 by $18\frac{1}{2}$.

6. The buildings and grounds of a public institution comprise 60 acres in the form of a rectangle which is only $\frac{3}{5}$ as long as it is broad; what is its length?

7. A man buys a piece of land and sells it again in such a way as to receive as much for every 6 sq. yd. as he gave for 7 sq. yd.; how much does he gain on every £100 he laid out?

8. If he had received as much for every 6 sq. yd. as he gave for 5 sq. yd., would he have gained or lost? and how much on £100?

9. What is the difference between $\frac{1}{10}$ and $\frac{1}{21}$ of £22, 1s.?

10. If 25 francs be equal in value to 19s. 6d., how many francs are worth £19, 10s.?

Exercise 37.

1. Reduce 5 yd. 2 ft. 7 in. to the vulgar fraction of a *foot*.
2. Express 3 tons 17 cwt. as the decimal of a *ton*.
3. Convert 17 leagues $\frac{3}{4}$ mile into the decimal of 10 leagues.
4. Express 2432 pence as £ s. d.
5. What fractional part of 5s. 3d. is ·7 of 5s. 10d.?
6. Express 51 yd. as poles, yd., &c.
7. In 16 English ells 2 nails, how many inches?
8. How many inches in 308 nails (*cloth measure*)?

9. How many square inches are there in the area of a triangle whose base measures 5 ft., and perpendicular height 2 ft. 7 in.?

10. What must be the perpendicular height of a triangle whose base is 14 ft. 1 in., and area equal to that of a square whose side measures 10 ft. 10 in.?

Exercise 38.

1. From $\frac{5}{8}$ of £1 take $\frac{1}{7}$ of a guinea.

2. Divide 40 roods of ground among 5 men and a boy, each man's share being twice that of the boy. A man's share =

3. Reduce $19\frac{3}{11}$ to an improper fraction.

4. Express $4\frac{3}{4}$ as an improper fraction, having 20 for its denominator.

5. $\frac{3}{11}$ of $6\frac{1}{20} =$

6. What decimal fraction of 14s. 3d. is 4s. 9d.?

7. If a cistern can be filled by a pipe in $2\frac{1}{2}$ minutes, how many gallons are poured in by this pipe per minute, supposing that it can be emptied in 10 minutes by another pipe which passes 23 gallons a minute?

8. Find the price of 620 articles at 9s. $11\frac{1}{2}$d. each.

9. What number contains $4\frac{1}{3}$ the same number of times that 21 contains $5\frac{1}{4}$?

10. What quantity is the same fraction of 2s. 6d. that 2 yd. 1 ft. is of 35 yd.?

Exercise 39.

1. If the price of $\frac{1}{3}$ of an acre of land be $£\frac{7\text{s}.}{6}$, what will be the value of 5 acres?

2. The value of $\frac{1}{2}$ of a cwt. being $£1^{0}_{9}$, how many cwts. can be bought with £1, 12s.?

3. Commencing to build a house I expect it will cost me £350; how much more than this shall I have to pay if in the end I find that the actual cost of the house is to the anticipated cost as 4 is to 3?

4. A garrison contains 2400 men, and food enough to keep them 90 days; how many days will the provisions last if the garrison be reduced by 240 men?

5. In a certain sum the divisor is 312; by what fraction in its lowest terms must the dividend be multiplied in order that, if divided by 650, it may give a quotient similar to the first?

Exercise 40.

1. Find the cost of 900 pigeons at 1s. 6d. each.

2. A post which is $\frac{2}{3}$ in the ground is 25 inches above ground; what is its total length?

3. $\frac{1}{12}$ of the length of a journey being $25\frac{1}{2}$ miles, express its whole length in miles.

4. If a man performs $\frac{4\frac{1}{2}}{5\frac{1}{2}}$ of a piece of work in 45 days, how long will he take to do the whole work?

5. If another man having completed $\frac{5\frac{1}{2}}{6\frac{1}{2}}$ of the work can finish it in 10 days, how long ought he to be in performing the whole undertaking?

6. The value of a diamond being £3224, what will be that of another whose value is to the first as 9 : 8?

7. $\frac{1}{2}$ of $\frac{1}{3}$ being worth £500, what is the value of $\frac{2}{3}$ of $\frac{1}{4}$? *

8. $\frac{2}{3}$ of $\frac{3}{7}$ being worth £307, 19s. 11½d., what is the value of $\frac{4}{7}$ of $2\frac{2}{3}$?

9. $\frac{8}{11}$ of $\frac{5}{8}$ being worth £831, 10s. 10d., what is the value of $1\frac{1}{4}$ of $\frac{8}{11}$ of 2?

10. $\frac{3}{4}$ of $1\frac{1}{3}$ of $2\frac{1}{4}$ being valued at 10s. 3½d., what is the value of 3 times 7 times $4\frac{1}{2}$?

Exercise 41.

1. Divide $18\frac{1}{4}$ by 13.

2. A man, a woman, and a boy enter an eating-house, and dine together; the man, who pays for the boy as well as for himself, pays in all twice as much as the woman. The total cost being 4s. 6d., and the man's dinner costing twice as much as the boy's, how much did each dinner cost?

3. Find the G. C. M. of 82, 205, 533, and 451.

4. Find the G. C. M. of 153, 85, 68, and 51.

5. Find the G. C. M. of 1812, 2416, 2718, and 12080.

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* This and the next three sums will repay careful inspection, and will be found useful in training pupils to readily observe the comparative values of fractions.

6. Find every number of children among whom 8s. 10d. may be evenly distributed so as to give each an exact number of pennies.*

7. Find the least sum of money which can be exactly made up of threepences, sevenpences, tenpences, florins, and half-guineas.

8. How many sq. in. are there at least in a square sheet of lead which may be cut exactly into rectangles which are 7 in. long and 3 inches wide?

9. And how many in another sheet of a rectangular shape which could be exactly cut up into rectangles of 5 inches by 4, the whole sheet being twice as long as it was broad.

10. Divide each of the digits, 1, 2, 3, 4, 5, 6, by 7, expressing the quotients in the decimal notation; examine these quotients, carefully marking the figures of which they are composed, and the order in which these figures succeed each other, and then find, correct to six places of decimals, the difference between $\frac{1}{7}$ and $\frac{1}{11}$.

Exercise 42.

1. A gentleman who has spent $\frac{4}{13}$ of his money still possesses £279; how much has he spent?

2. *Divide* $\frac{3}{8}$ of 20 *by* 5.

3. How many paces will a person take in walking a mile, if he takes 3 paces in every four yards?

4. If a brick be 7 inches long, 4 broad, and 3 thick, and a tank be 7 yards long, 4 feet broad, and 3 feet thick, and also half filled with water, how many bricks must be put into the tank in order that the water may reach its top?

5. The English *imperial gallon* contains 277·274 cubic inches. How many cubic inches of wood are there in a tree which, when dropped into the river, displaces 4000 gallons of water?

6. How many yards of carpet, 29 inches wide, will be required to cover a room which is 14½ feet wide and 60 feet long?

7. Twelve dollars, four florins, and 6 half-crowns are together worth £3, 13s.; the value of a dollar =

8. What would be a gentleman's nett income, after paying Income-tax on £720, at 3d. in the £1?

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* Prepare the way for this question by some problems upon the reducing of numbers into their prime factors.

9. A French *franc* is worth 9¾d.; how many francs are worth 39 guineas?

10. A gentleman invests ⅝ of his property in a business by which his investment is soon doubled. He now possesses altogether £3900; how much money had he at first?

Exercise 43.

1. 960 bottles of oil at 11¾d. a bottle, cost ——?
2. Find the cost of 380 lb. of cocoa at 4s. 2d. per lb.
3. 431 × 625.
4. 380198057 ÷ 19.
5. 700700 ÷ 800·8.
6. 68264400 ÷ 3⅛.
7. The butter eaten at a breakfast was worth 3 times the bread, and the bread was worth ¼ the meat; find the cost of each, supposing the value of the whole to have been 6s. 8d.
8. It takes a boy 31 days to transcribe 413 pages of a manuscript; how many pages would he be able to transcribe in 341 days?
9. Find the difference between 850 × 25 and 850 ÷ 25.
10. By how many does 74 *increased* by ⅛ of 7599 exceed 74 *diminished* by ⅛ of 7599?

Exercise 44.

1. Multiply £33, 9s. 10½d. by 23.
2. Having divided £700, 10s. 1d. by 22, how many farthings remain?
3. One field is ⅛ larger than another; if this last one contain 14 ac. 1 r., what is the size of the two together?
4. How much coffee may be purchased for £40½ when 2 lb. are bought for 3s. 4½d.?
5. When the price of 19 yards of window curtain was £4, 0s. 9d., how many yards could be bought for £48, 17s. 6d.?
6. 42157 × 17 =
7. The value of 151 articles at 24s. each =
8. 7½ dozen articles at 4½d. each.
9. Reduce 10 sq. yd. 5 sq. ft. 90 sq. in. to sq. in.
10. I gave 2s. for an arithmetic book, this price being to the published price as 5 : 8¾; what was the cost price of this book to the publisher, supposing his gain to be to the cost as 4⅔ : 11⅔?

Exercise 45.

1. The value of $\frac{8}{15}$ of 1 lb. avoirdupois expressed in ounces =

2. Express $\frac{317}{125000}$ as a decimal.

3. A writing desk is 8 inches high at the back and 3 at the front. If it be 18 inches long and 15 wide, how many cubic inches does it contain?

4. If an object 21 ft. high casts a shadow $10\frac{1}{2}$ yd. in length, how high will an object be which casts a shadow of 35 inches?

5. A dishonest tradesman sells 11 yd. of cloth and charges for $12\frac{1}{2}$ yd., thus receiving 9s. 6d. too much; find the *real price* and *the selling price*, and *the real price per yard*.

6. A window contains 72 panes of glass, each of which measures 6 in. by $4\frac{1}{2}$ in.; the interior of the frame which contains the window is 60 in. long by 36 wide; how much superficial space is occupied by the wood-work between the panes?

7. In the following "Proportion" by what number must the 8 be multiplied to make its statement good?

$$31 : 8 :: 155 : 65.$$

8. Ten pictures with their frames cost 18s. 4d.; the value of each picture being $\frac{4}{7}$ of that of its frame, what was the value of each picture and each frame?

9. Find the value of x in the following equation: $\frac{100 \text{ guineas}}{300 \text{ crowns}} = \frac{2 \text{ qr. } 14 \text{ lb.}}{x}$.

10. What is the value of the contents of a till which contained 20 sovereigns, 17 half-sovereigns, 24 crowns, 103 half-crowns, and 17 pence?

Exercise 46.

1. How many times may 1s. 3d. be taken from £12, 17s. 6d.?

2. Two railway stations are 5 miles apart, and situated between them there are 175 telegraph posts; what is the average distance between each post? [Express the answer in *yards*.]

3. By what number must 85 be multiplied to make it equal to the sum of 31 *times* 5 and 27 *times* 10?

4. Reduce $\frac{8}{15}$ and $\frac{11}{20}$ to equivalent fractions having 2860 for their common denominator.

5. By what fraction must $\frac{3}{8}$ be divided to give 5 for its quotient?

6. The price of 108 gallons of beer at 1s. $3\frac{3}{4}$d. per gallon =

7. Square 85 and increase the product by 30.

8. Multiply 1707 by $62\frac{1}{2}$.

9. If a man pays 2d. in the £1 Income-tax, thereby reducing his annual income to £476, how much Income-tax did he pay?

10. Find the cost of 479 articles at £2, 3s. $3\frac{1}{2}$d. each.

Exercise 47.

1. $3\frac{1}{4} \times 83 =$

2. Add to £3, 17s. 10d. fifteen times its present value, and divide the result by four.

3. How many square feet are there in an acre and a half?

4. If 47 nuts are sold for $1\frac{1}{2}$d., what is the price of 940 nuts?

5. How many cubic inches are there in a cube whose side contains 225 sq. in.?

6. How many sq. in. are there in the side of a cube which contains 729 cub. in.?

7. How many cub. ft. are there in a rectangular solid, the end of which is a square containing 6400 sq. ft., and the side of which contains 16,000 sq. ft.?

8. A rectangular solid contains 300,000 cub. ft.; if its longest side measured 40 yards, and its smaller face formed a square, how many inches were contained in its width?

9. The price of a picture is to that of its frame as $9\frac{1}{2} : 11\frac{1}{2}$. If 100 such pictures cost £38, by how much must this sum be diminished to give the difference between the cost of 50 such pictures and that of their frames?

10. A dealer in old clothes always asks for an article one-fourth more than the price he expects to get for it; he, however, one day sold a pair of trousers for 11s. 3d., having on this occasion received a sum of money which was exactly one-half of the sum of the marked price and the price he would have taken for it according to his usual manner of reduction. What was the marked price of the trousers?

ANSWERS.

Exercise 1.

1. £380.
2. 161.
3. 108.
4. 5s. 10d.
5. 9¾d.
6. 18.
7. 7½.
8. 5¼.
9. 3½d.
10. 1¾d.
11. 9.
12. 5.
13. £70.
14. £7, 10s.
15. £9.

Exercise 2.

1. 12.
2. 84.
3. 21.
4. 90.
5. 6d.
6. 9d.
7. 1s. 9d.
8. 156.
9. £5, 17s.
10. 2s. 11¾d.
11. £1, 18s.
12. 6s.
13. £1, 12s.
14. £24.
15. 4s. 1½d.

Exercise 3.

1. 4½d.
2. £3, 16s.
3. £5.
4. £1, 8s.
5. 11s. 8d.
6. £8, 8s.
7. 2s. 1d.
8. £12, 5s.
9. £8.
10. 7½ oz.
11. £2, 12s. 6d.
12. 7.
13. 98.
14. 3s. 9d.
15. 10.

Exercise 4.

1. £17, 8s. 6d.
2. 10s.
3. £24800.
4. 10s. 6d.
5. 5s.
6. £28.
7. 7s. 7¼d.
8. 3d.
9. 9 lb.
10. £40.
11. 34.
12. £3, 6s. 8d.
13. 5s. 1¼d.
14. 1s. 5½d.
15. 4s. 4d.
16. 8s.

Exercise 5.

1. 2150 miles.
2. 42 ft.
3. 2138.
4. B.C. 510.
5. 5.
6. $33\frac{3}{4}$.
7. 100 days.
8. 5280.
9. 25.
10. 5.
11. 3080.

Exercise 6.

1. 18; 87; 43; 40; 160; 162.
2. 30; 50; 125; 43; 420; 636; 640; 2120; 2808; 1219.
3. 200.
4. 45.
5. 19.
6. 9.
7. $166\frac{2}{3}$ poles.
8. 2 yd. 1 ft.
9. 4s. 7d.
10. 2520.
11. £98.
12. 7.
13. 15.
14. 63.
15. $13\frac{1}{2}$.
16. 5.
17. 184.
18. 324.

Exercise 7.

1. 8; 6; 15; 70; 145; 82.
2. 8; $5\frac{1}{2}$; $2\frac{1}{3}$; $3\frac{3}{5}$.
3. $7\frac{5}{12}$; $11\frac{7}{10}$; $111\frac{1}{5}$.
4. $5\frac{2}{7}$; $17\frac{1}{60}$; $2\frac{1}{3}$; $2\frac{1}{7}$.
5. $3\frac{1}{3}$; $4\frac{1}{17}$; $18\frac{2}{105}$.
6. $68\frac{4}{7}$; $191\frac{13}{17}$; $605\frac{33}{34}$.
7. £117, 12s.
8. $298\frac{2}{3}$.
9. 2 m. 1720 yd.; $2\frac{13}{11}$ m.
10. 132.
11. $62\frac{1}{2}$.
12. 1005 f.
13. £11.
14. 100 yd.
15. 9s. 2d.
16. £11, 5s.
17. 85 sq. yd.
18. 9.

Exercise 8.

1. 160; 470; 3050; 8730; 2070; 610030.
2. 1900; 7300; 65000; 805000; 1790100; 40700.
3. 75; 55; 1155.
4. 350; 275; 625; 4400; 18600.
5. 131000; 2730000; 804900000; 670000; 20800000; 1940000 1815000.
6. 870; 14880; 624600; 1170000; 780000; 2400000; 462000.
7. 40 sq. ft.
8. £2, 14s. 2d.
9. £3, 2s. 6d.

Exercise 9.

1. 8300; 177000; 51000; 8800.
2. 20200; 120000; 1050.
3. $381\frac{2}{3}$; 10200; $8209\frac{1}{11}$; $586777\frac{7}{9}$.
4. £40; £1200; £240; £5500; £440; £330.
5. 450; 4075; 5175; 4750; 8625; 6875; 175; 9750.
6. £170; £1400; £1100.
7. 51 tons.
8. £30
9. £200.
10. 80.
11. 41.
12. 18.
13. 10.

Exercise 10.

1. 1575; 177250; 457500; 92·5.
2. 1350; 192·5; 13250; 471250.
3. £658, 6s. 8d.
4. 60 yd.
5. 2250.
6. 3600.
7. 294.
8. 40.
9. 300 hrs.
10. £10.
11. £20000.
12. £158, 6s. 8d.
13. 60 days.

Exercise 11.

3. 530000; 240000; 700000; 2375000; 573125; 251250; 443125.
4. 5600000; 470000; 4100; 16000; 11000; 20100; 45875; 560750.
5. £17750; £2200; £110000; £56500.
6. 67500.
7. 10000.
8. 8400.
9. 393129 sq. in.
10. 33125.
11. 6100000.
12. 5125.

Exercise 12.

2. 1100000; 1200000; 1700000; 70000; 210000; 31000; 16000.
3. £10000; £5000; £2025; £60000.
4. £233, 15s.
5. £2593, 15s.
6. 15000; 150000.
7. 2553125.
8. 37·5.
9. 4500000.
10. 5859·375 sq. ft.
11. 4335 sq. in.
12. 15 ft.; 35 ft.

Exercise 13.

1. 3·63; 3·755; 26·13; 4·17; 367·98; 669·39.
2. £432; £37, 10s.
3. 64200; 806; 8·93; 2·473.
4. 70500; 7·05; 70492·95.
5. 3s. 6d.
6. 1100.
7. 47 yd.
8. 33·64 yd.
9. 763 sq. ft.
10. ·735; ·86$\frac{1}{4}$; ·313$\frac{5}{8}$; 3·01; 2·06; 5003; 20·03.
11. 2800 pence.
12. 93·17.
13. 116·875.

Exercise 14.

1. £720, 12s.
2. 1008.
3. 8.
4. 24.
5. 15s. 9d.
6. 1$\frac{3}{4}$d.; 1s. 9d.
7. 105.
8. £1, 12s.
9. 6756; 67560.
10. 1 hour.
11. 5s. 6$\frac{1}{2}$d. per day
12. 360 pence.
13. 62708$\frac{1}{2}$.
14. 1125.

Exercise 15.

1. 100.
2. 2584·8.
3. 777.
4. 27.
5. £3, 9s. 9d.
6. £19.
7. £221.
8. 20.
9. 71.
10. 34.
11. 296.
12. 12.
13. 294.

Exercise 16.

1. £9.
2. £14.
3. £14.
4. 248.
5. 306.
6. 28; 12.
7. 48.
8. £146; £728.
9. 26.
10. 264.
11. 50.
12. £14.
13. £3.

Exercise 17.

1. £23.
2. 348.
3. 1664.
4. 37.
5. £110.
6. 116$\frac{3}{4}$.
7. £352.
8. £72.
9. £154.
10. 423.
11. £48, 2s. 6d.
12. £180.
13. £56, 13s. 9d.

Exercise 18.

1. £55, 13s.
2. £28, 7s.
3. £36.
4. 64 weeks.
5. 1½d.; 240.
6. £48, 6s.
7. £34, 4s.
8. £135.
9. £90, 18s.
10. 204.
11. 6s. 8d.
12. £53, 11s.
13. £5, 15s. 6d.

Exercise 19.

1. £3, 19s. 6d.
2. £4, 9s.
3. £1, 16s. 3d.
4. £10, 13s. 4d.
5. £3, 3s. 6¾d.
6. £3, 3s. 6¾d.
7. £21, 14s.
8. £3, 9s. 8d.
9. £19, 19s.
10. £13, 15s.
11. £156, 15s.
12. 24.
13. £27.

Exercise 20.

1. £19.
2. £5.
3. £26.
4. £33, 9s. 2d.
5. £7.
6. £49, 17s. 11d.
7. £5, 6s. 8d.
8. 10s. 6½d.
9. £6, 16s. 8d.
10. £8, 12s. 1d.
11. 240.
12. 64 times.
13. 2892.

Exercise 21.

1. £3, 10s.
2. £8, 10s.
3. £9, 10s.
4. £14, 19s. 8½d.
5. £9, 17s. 8½d.
6. £54.
7. £15, 10s. 1d.
8. £1, 13s. 5½d.
9. £11, 10s.
10. £85.
11. 9s. 9½d.
12. 4s. 0¾d.
13. 200.

Exercise 22.

1. 12.
2. 80.
3. 147.
4. 12.
5. (1.) 8½.
   (2.) 12.
   (3.) 48.
   (4.) 30.
   (5.) 6.
   (6.) 25.
   (7.) 24½.
   (8.) 20.
   (9.) 49½.
   (10.) 7½.
   (11.) 46½.
   (12.) 9.
   (13.) 72.
   (14.) 20.
   (15.) 60.
   (16.) 64.
   (17.) 170.
   (18.) 60.
   (19.) 90.
   (20.) 60.
   (21.) 62.
   (22.) 100.
6. 60 yd.

Exercise 23.

1. 735.
2. 6s. 8d.
3. £5, 12s.
4. 19s. and 17s.
5. 15.
6. 800.
7. 3s. 4d.
8. 18.
9. £3, 2s. 6d.
10. 1400.
11. $1\frac{1}{11}$.
12. $21\frac{7}{18}$; $41\frac{1}{7}$; $10\frac{8}{11}$.
13. £30, 11s. 5d.; £43, 4s. 5d.

Exercise 24.

1. 225.
2. 11673.
3. 22.
4. 5.
5. 2d.
6. 3s. $3\frac{3}{4}$d.
7. £25, 10s.
8. 1413.
9. 97400.
10. 1287.

Exercise 25.

1. 90.
2. £35.
3. 16.
4. 3s.
5. £1, 10s.
6. 1s. 6d.
7. No. No. Yes. $5\frac{1}{2}$.
8. 77.
9. 339.
10. 105.

Exercise 26.

1. £41, 0s. $6\frac{3}{4}$d.
2. £1.
3. 1s. $10\frac{3}{4}$d.
4. £1, 11s. $7\frac{3}{4}$d.
5. None; 18 must be taken away.
6. 504.
7. 19000.
8. 195.
9. 100.
10. $178\frac{1}{2}$.

Exercise 27.

1. $1006\frac{1}{2}$.
2. 4530.
3. 11.
4. 4s. $1\frac{1}{2}$d.
5. $6\frac{1}{2}$.
6. 5d.
7. 5s. 6d.
8. 9s. $8\frac{1}{2}$d.
9. 1s. 5d.
10. 74.

Exercise 28.

1. 459.
2. £92, 6s. 8d.
3. $17\frac{1}{2}$.
4. 3s. $6\frac{1}{2}$d.
5. £1, 5s. 10d.
6. £18, 5s. 6d.
7. £7, 1s. 9d.
8. $\frac{48}{101}$.
9. 10.
10. $10\frac{1}{2}$ cwt.

Exercise 29.

1. 4s. 3d.
2. £5239.
3. 244.
4. 325½ m.
5. 10.
6. £22, 16s. 3d.
7. 68.
8. 19s. 6d.; £1, 9s. 3d.
9. 16.
10. 126.

Exercise 30.

1. 58.
2. £7.
3. £80.
4. 1 oz.
5. 8½d.
6. 16s. 6d.
7. 243.
8. £3, 18s. 11d.
9. £2, 1s. 11½d.
10. £6, 5s. 10½d.

Exercise 31.

1. £2, 6s. 6d.
2. 1s. 8½d.
3. 2s. 2d.
4. 2629¼.
5. 98.
6. 5¼d.
7. 8s. 10½d.
8. £1, 15s. 5d.
9. 3s. 6½d.
10. 18¾ m.

Exercise 32.

1. 6s.
2. £1, 4s.
3. £2, 6s. 0½d.
4. 9¾d.
5. £2, 15s. 3d.
6. 6.
7. 41160.
8. 45 lb.
9. 1750.
10. £104.

Exercise 33.

1. 10421.
2. £1218, 7s. 7d.
3. 213.
4. 5833.
5. £5, 4s. 6d.
6. 580800.
7. 66 yd.
8. 20 ft.
9. £466, 13s. 4d.
10. £13, 13s.

Exercise 34.

1. £1, 12s. 6d.
2. 199·98.
3. £3, 5s. 4d.
4. 14s. 7½d.
5. £28, 2s. 6d.
6. 3120.
7. 7280 lb.
8. 163200.
9. 150750.
10. 7130000.

Exercise 35.

1. £20.
2. $\frac{1}{80}$.
3. 4s. 4½d.
4. 2½.
5. 30.
6. 4380.
7. 504.
8. 14400.
9. 5280.
10. 7s.

Exercise 36.

1. 533.
2. 7 o'clock.
3. 120.
4. 96.
5. 7585.
6. 660 yd.
7. £16, 13s. 4d.
8. £20 lost.
9. 1s. 0¾d.
10. 500.

Exercise 37.

1. $17\frac{7}{19}$.
2. 3 85 tons.
3. 1·725.
4. £10, 2s. 8d.
5. $\frac{7}{9}$.
6. 9 po. 1 yd. 1 ft. 6 in.
7. 724½.
8. 693.
9. 930.
10. 200 in.

Exercise 38.

1. 1s. 8d.
2. $7\frac{3}{11}$ roods.
3. $\frac{21}{11}$.
4. $\frac{23}{30}$.
5. $1\frac{13}{20}$.
6. $\cdot\dot{3}$.
7. 92 galls.
8. £308, 14s. 2d.
9. $17\frac{1}{3}$.
10. 2d.

Exercise 39.

1. £1280.
2. $\frac{14}{15}$ cwt.
3. £116, 13s. 4d.
4. 100 days.
5. $\frac{25}{12}$.
6. £67, 10s.

Exercise 40.

1. £67, 10s.
2. 100 inches.
3. 31½ miles.
4. 55 days.
5. 52 days.
6. £3627.
7. £500.
8. £615, 19s. 10½d.
9. £9978, 10s.
10. £20, 10s. 10d.

Exercise 41.

1. $1\frac{2}{3}$.
2. 1s. 6d.; 2s.; 1s.
3. 41.
4. 17.
5. 302.
6. 1, 106, 2, 53.
7. £10, 10s.
8. 441 sq. in.
9. 200 sq. in.
10. ·051948.

Exercise 42.

1. £124.
2. $1\frac{1}{2}$.
3. 1320.
4. 2592.
5. 1109296.
6. 120.
7. 4s. 2d.
8. £711.
9. 1008.
10. £2400.

Exercise 43.

1. £47.
2. £79, 3s. 4d.
3. 269375.
4. $20010424\frac{1}{15}$.
5. 875.
6. 21844608.
7. 2s. 6d.; 10d.; 3s. 4d.
8. 4543.
9. 21216.
10. 7599.

Exercise 44.

1. £770, 7s. $1\frac{1}{2}$d.
2. 10.
3. 33 ac. 1 r.
4. 480 lb.
5. 230.
6. 716669.
7. £181, 4s.
8. £1, 13s. 9d.
9. 13770 sq. in.
10. 2s. 6d.

Exercise 45.

1. $11\frac{1}{12}$ oz.
2. ·002536.
3. 1485 cub. in.
4. 23 inches.
5. £3, 9s. 8d.; £3, 19s. 2d.; 6s. 4d.
6. 2 sq. ft. 72 in.
7. $1\frac{5}{8}$.
8. 1d.; 1s. 9d.
9. 1 qr. 22 lb.
10. £47, 8s. 11d.

Exercise 46.

1. 206.
2. 50 yards.
3. 5.
4. $\frac{1100;\ 1573}{2860}$.
5. $\frac{3}{10}$.
6. £7, 1s. 9d.
7. 7255.
8. $106687\frac{1}{2}$.
9. £480.
10. £1036, 16s. $8\frac{1}{2}$d.

Exercise 47.

1. $269\frac{3}{4}$.
2. £15, 11s. 4d.
3. 65340.
4. 2s. 6d.
5. 3375.
6. 81 sq. in.
7. 1280000.
8. 6000.
9. £34.
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